MULTIMEDIA TECHNOLOGY STANDARDS ASSESSMENT

VERSION 2

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Prepared for:

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FOREWORD

This document is a revision of the Defense Information Systems Agency (DISA), Center For Standards (CFS) September 1993 *Multimedia Technology Standards Assessment* publication. During preparation of this revision, editing focused on updating, amplifying, and expanding various sections for clarity and currency. Additionally, the document has been reorganized and many new features have been incorporated. Among these are a glossary and list of acronyms to clarify terminology surrounding this complex technology and World Wide Web (WWW) Universal Resource Locators (URLs) for most standards.

Aspects of multimedia standards not addressed in detail in this updated document are security, networking, and virtual reality. These multimedia standards issues are candidates for future publications.

EXECUTIVE SUMMARY

The convergence of computing and communications technologies has affected the province of everyday concepts of work and life. In response to this convergence, a multimedia subculture has evolved that influences the manner in which Government and industry leaders from telecommunications, entertainment, and computing deal with seamless, transparent, end-to-end information transfer systems. For the Department of Defense (DoD), interest centers on how multimedia technology can favorably affect the rapid transfer of information to warfighters and battlefield commanderswhen and where it is needed.

What exactly is multimedia? While there are many popular definitions, a *universal* definition of multimedia remains defiantly elusive. The Interactive Multimedia Association (IMA) uses the following definition:

> **Multimedia:** Two or more media types (audio, video, imagery, text, and data) electronically manipulated, integrated, and reconstructed in synchrony.

This definition is adopted for this document.

Until recently, the multimedia environment has had few guidelines and no universally defined portability, data exchange, or interoperability standards. Despite more than four decades of research, essential multimedia standards for mixes of audio, video, animation, and imaging subsystems are still missing from mixed-media system architectures. Many vendor standards remain proprietary, further complicating collaborative, interactive system integrations. The pace of evolving multimedia standards to address these issues is staggering with standards under continual review by formal working groups, committees, and consortia. Many multimedia standard descriptions and specifications are outdated by the next media release or conference.

As multimedia applications move more rapidly into the interactive information mainstream, awareness of the scale, sophistication, and coordination of advances in multimedia standards is essential. Among these are multimedia standards for sound, full-motion video recording and playback, television engineering, and digital signal compression and processing. Technology standards for supporting distributed network applications and coding must also be considered. These standards can affect most multimedia applications.

In view of the significance of multimedia standards, this document revises the DISA, CFS September 1993, *Multimedia Technology Standards Assessment* publication which addressed application standards then used throughout the multimedia community. It revises the earlier work and incorporates current and emerging multimedia application areas and companion standards within these areas. It also follows the same general outline, except where new sections have been added to accommodate entirely new material.

The CFS does not advocate or recommend any specific multimedia standards contained in this document. The document's purpose is to provide an assessment and current summary, or catalogue, of formal and *de facto* multimedia standards. The intent is that this document will serve as a reliable reference and as a valuable educational tool. It also can provide guidance for multimedia developers, information system architects, design engineers, acquisition mangers, and procurement officials. Document revisions are summarized below:

- **Appendix A** has been reformatted. Descriptions of new standards have been incorporated to augment multimedia standards descriptions in the original document. Earlier standards data have been expanded and updated based upon current information.

  This appendix has also been divided into 12 sections based on multimedia software type: A.1 Graphics, Raster; A.2 Graphics, Vector; A.3 Graphics, Mixed; A.4 Video, Analog; A.5. Video, Digital; A.6 Audio, Digital; A.7 Video/Audio Mix; A.8 Multimedia Scripting; A.9 Text; A.10 Optical Media; and two entirely new sections, A.11 Distributed Multimedia, and A.12, Futures.

  As a new feature, each Appendix A section describes what standards must be considered when meeting task or project requirements. A description of how they can affect an application is also included.

- **Appendix B**: A List of Acronyms, and their meanings, used throughout the document

- **Appendix C**: A Glossary of multimedia terms included in the document

- **Appendix D**: A listing of References used in developing this document

For reader convenience, two indexes have also been added at the end of the document:

- **Index A:** A Multimedia Standards Index by Subject Format, alphabetical within the format

- **Index B:** An Alphabetical Index, using common names of the standards

As the multimedia phenomenon accelerates, standards become more critical. They will be based on the pervasiveness of the technology and advances and challenges surrounding information systems compatibility, portability, and interoperability.
In response, multimedia standards are evolving rapidly to support interactive multimedia applications dealing with synchronized, time-based media in distributed environments. To provide a current reference, it is intended that this document will be revised periodically as multimedia technology standards continue to evolve.

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1. INTRODUCTION

1.1 BACKGROUND

Today, computers are used for more and more complex tasks, often involving multiple programs and a variety of media (multimedia). Projects now involve a continually expanding and changing universe of computer systems and communication networks and a growing demand for custom software to accommodate multimedia applications. In response to competitive pressures, developers and vendors are constantly adding features to their products that generate even larger and more complex proprietary, non-standard applications. As applications become more powerful in terms of features, they are also more difficult to use and design into interactive information communications systems.

With these advances, the rapid convergence of communications and computing technologies has stimulated extensive research in multimedia applications that impact system designs, user interfaces, and distributed network architectures. The personal computer (PC), for example, can now interact through distributed communications system networks to deliver all types of media: text; still images and animation; graphics; audio; and with appropriate hardware and software augmentations, full-motion video. Users now expect a PC-based multimedia system to be capable of all the usual computer presentation types (text, graphics, animation, etc.) plus recorded real audio, full-screen motion video of real scenes, and photographic-quality still images. Such multimedia systems can do everything normally expected on a television. While also being a computer, it can at the same time display computer objects on the same screen. Moreover, the PC brings to multimedia two important technical augmentations: the ability to present multimedia applications in an (1) integrated and (2) interactive fashion.

The convergence of communications and computer science has also resulted in multimedia data that are widely dispersed throughout literature, difficult to access, and not treated coherently. This also is true of essential companion multimedia standards critically needed to link applications and formats to ensure cross-platform compatibility. Consequently, the goal of universal access and distribution of information using multimedia systems technology requires a significant amount of interoperability based upon standards.

Figure I illustrates this multimedia convergence. Shown are the interrelated basic multimedia system models, their major components, and the essential role multimedia standards play to ensure dissimilar platform interoperability.

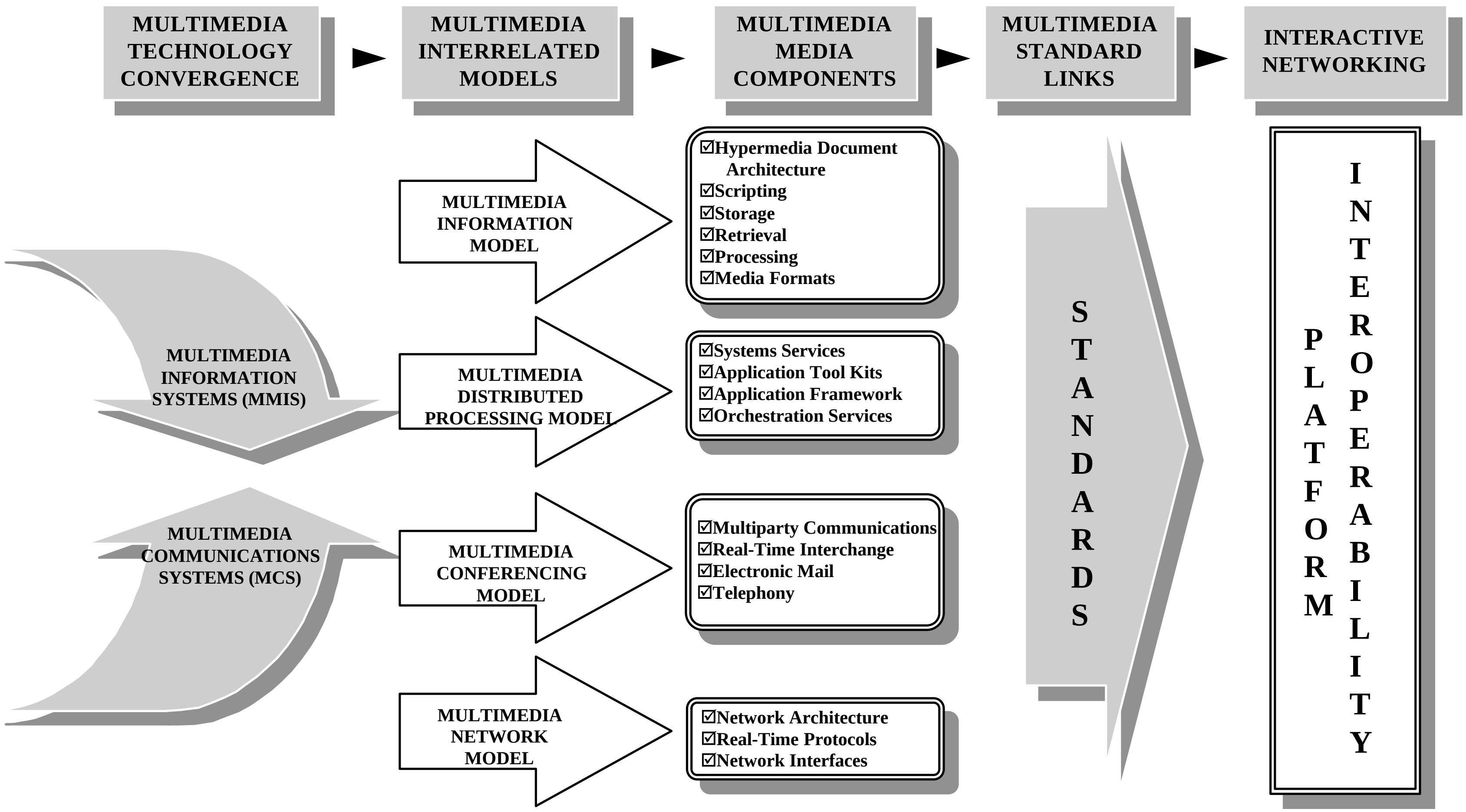


Figure I. Distributed Multimedia Systems Framework Showing Components Essential for the Integration of Multimedia Computing and Communications Technologies and Standards into Interactive Networks

Buford, John F. Koegel, *Multimedia Systems*, ACM Press, New York, N.Y., 1994. (Modified)

In the past, developing multimedia standards for computer applications has not been a planned or organized process. Typically, standards have been set by a few manufacturers or the Government, with individual developers and vendors creating software for a specific platform or creating unique software for multiple platforms.

To illustrate, Table I shows examples of several popular multimedia standards by user and defining body: International Standards Organizations/International Telecommunications Union (ISO/ITU), trade group, or vendor. Clearly, the scope of standardization activities is broad and extremely complex. Even now, some of the table's data may be outdated due to rapid technology advances. Additionally, *competing standards* continue to be produced by multiple standards bodies, trade groups, and vendors with significant market presence and leverage. An optimistic sign is that national and international standard-setting organizations have been meeting and working together tirelessly to implement universal standards that will eventually enable efficient interactive networking.

Table I. Catalogue of Multimedia Standards

USER	FUNCTION	ISO/ITU	TRADE GROUP	VENDOR
AUTHOR	Scripting Language Hypermedia Document Architecture	SMSL SGML/Hytime SMDL HTML		Kaleida Labs Script X Gain Momemtom GEL
DEVELOPER	Distributed Object Arch. UI Toolkits	ODP PIKS PREMO	OMG CORBA X Consortium XIE COSE	Microsoft OLE Apple QuickTime Microsoft MME
SYSTEM VENDOR	Multimedia System Services Multimedia Mail Interchange Format	MHEG	IMA RFT COSE UNIX Intl IETF MIME IMA RFT OMFI	Apple QuickTime Movie File Format Microsoft AVI
NETWORK PROVIDER	Multiservice Network Protocol Stack	ATM FDDI-II OSI	IEEE 802.6 IETF RTP	
PUBLISHER	Storage Formats Media Formats	9600 MPEG,-2,-4 JPEG H.261	Rock Ridge MMA MIDI	Kodak PhotoCD Phillips CD-I Intel DVI

<u>Software Magazine,</u> December 1995.

As Executive Agent for the Department of Defense (DoD) Information Technology (IT) Standards Program, the Defense Information Systems Agency (DISA) is responsible for integrating, coordinating, and managing all DoD IT standards. Within DISA, the Joint Interoperability and Engineering Organization (JIEO), Center for Standards (CFS) is assigned Executive Agency responsibilities for the IT standards program. Under this charter, the Information Processing Depart ment of the DISA/JIEO/CFS has been assigned responsibility for managing multimedia standards. In September 1993, the CFS published a *Multimedia Technology Standards Assessment* document to catalogue standards used through out the multimedia community. This document updates the original work.

1.2 DEFINITION OF MULTIMEDIA

There are many definitions of multimedia, but no definition is universally accept ed. In general, multimedia combines two or more real-world media forms in computing (audio, images, video, text, animation, etc.). Linking of any type of media is called *hypermedia*. However, multimedia also refers to the interactive use of ***multiple digitized media*** in all aspects of computing. The Interactive Multimedia Association (IMA) uses the following defini tion:

> **Multimedia** **:** Two or more media types (audio. video, imagery, text, and data) electronically manipulated, integrated, and reconstructed in synchrony.

This definition is adopted for this updated assessment.

1.3 PURPOSE

The purpose of this update to the CFS's September 1993 *Multimedia Technology Standards Assessment* document is to serve as a reliable reference and valuable educational tool. In addition to aiding multimedia developers, this updated document will provide guidance and serve as a reference source for information system architects and design engineers, acquisi tion mangers, and procurement officials to select appropriate multimedia standards for their projects. While there may be unintentional oversights, the document summarizes and catalogues the current status of widely recognized multimedia standards at the time of printing.

The CFS does not advocate or recommend any specific multimedia standards cited in this document. The document's purpose is to provide an assessment and current summary, or catalogue, of formal and de facto multimedia standards.

1.4 STANDARDS CRITERIA

Three fundamental standards criteria are emphasized throughout this document:

- **Duplicate standards at the same interface carrying the same semantic information should be avoided.** For example, an excess of raster file (still image) formats is unnecessary and creates an enormous burden on application developers.

- **Standards should specify semantics appropriate for information being exchanged at the interface being standardized.** Interchange that involves loss of information during the interchange usually leads to frustrated users who tend to blame the standard rather than criticize the judgment of the application designer. This undermines the standardization process and leads to resistance to acceptance of open system architectures.

- **Each important interface in a multimedia architecture or reference model must be addressed by an appropriate standard.** Proprietary and *ad hoc* "standards" often arise when no consensus (formal or consortia) multimedia standard is available. The multimedia community must anticipate the need for certain standards, develop them in advance of wide-spread need, and coordinate and promote them to facilitate interoperable, compatible systems and market expansion. Consortia and Government are especially well positioned to promote and sponsor trial-use of emerging multimedia standards.

1.5 REPORT ORGANIZATION

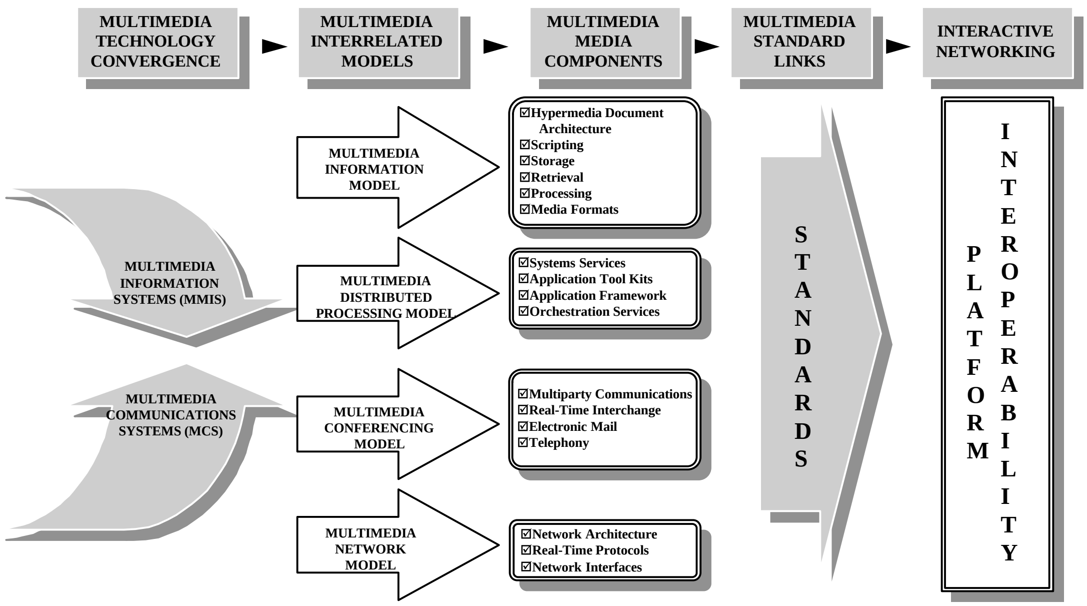
This *Multimedia Technology Standards Assessment* document examines multimedia technology standards in nine different aspects. Each of the nine assessment chapters deals with a specific multimedia standards technology using a structured format:

- A definition generally accepted within the multimedia community

- A discussion of the status of the state-of-the-art including glimpses into known evolutions

- A summary

Figure II shows the updated document's organization.



MULTIMEDIA TECHNOLOGY CONVERGENCE
MULTIMEDIA INTERRELATED MODELS
MULTIMEDIA MEDIA COMPONENTS
MULTIMEDIA STANDARD LINKS
INTERACTIVE NETWORKING
MULTIMEDIA INFORMATION SYSTEMS (MMIS)
MULTIMEDIA COMMUNICATIONS SYSTEMS (MCS)
MULTIMEDIA INFORMATION MODEL
MULTIMEDIA DISTRIBUTED PROCESSING MODEL
MULTIMEDIA CONFERENCING MODEL
MULTIMEDIA NETWORK MODEL
☑Hypermedia Document Architecture
☑Scripting
☑Storage
☑Retrieval
☑Processing
☑Media Formats
☑Systems Services
☑Application Tool Kits
☑Application Framework
☑Orchestration Services
☑Multiparty Communications
☑Real-Time Interchange
☑Electronic Mail
☑Telephony
☑Network Architecture
☑Real-Time Protocols
☑Network Interfaces
STANDARDS
PLATFORM
INTEROPERABILITY

Figure II. Organization of the Multimedia Technology Standards Assessment Document

Chapters 2 through 4 focus on motives for standardizing major elements of the multimedia environment:

- **Chapter 2:** **Multimedia and Application Portability:** The ease of operating a piece of software on different computer platforms
- **Chapter 3:** **Multimedia and Interchange:** The transferring of information between processes (e.g., applications or services)
- **Chapter 4:** **Multimedia and Interoperbility:** Successful interchange of both data and meaning

The next four chapters focus on multimedia application system environments:

- **Chapter 5:** **Multimedia Authoring:** Creating multimedia applications, or "titles" using distinctive authoring skills and resources
- **Chapter 6:** **Multimedia Delivery:** Specified file formats for the physical medium on which a multimedia title is played or presented

- **Chapter 7:** **Multimedia Playback:** Interface requirements to be satisfied by equipment that reads delivery formats and produces outputs to the user

- **Chapter 8:** **Multimedia Storage:** Devices that support long-term archival of collections of related multimedia data

The two concluding chapters address technical multimedia storage and transmission standards issues:

- **Chapter 9:** **Multimedia Distributed Processing:** Regulatory, technical, and market issues confronting multimedia applications in distributed, networked systems

- **Chapter 10:** **Multimedia Coding and Compression:** Agreed-upon coding and compression formats for interchange of multimedia files, formats, and data streams in distributed communications networks

Following the technology assessment chapters are approximately 140 descriptions of multimedia standards that impact Government, industry, and international applications. This revision of the document includes the World Wide Web (WWW) Universal Resource Locators (URLs) for most entries.

Appendix A is divided into 12 sections based on multimedia software type: A.1- Graphics, Raster; A.2 - Graphics, Vector; A.3 - Graphics, Mixed; A.4 - Video, Analog; A.5. - Video, Digital; A.6 - Audio, Digital; A.7 - Video/Audio Mix; A.8 - Multimedia Scripting; A.9 - Text; A.10 - Optical Media; and two new sections; A.11 - Distributed Multimedia, and A.12 - Futures.

As added features, each section in the appendix describes what standards must be considered when meeting task or project requirements and how they can affect an application. For reader convenience, two new indexes augmenting Appendix A are found at the end of the document: (1) an index by Multimedia Standards Format, alphabetical within format, and (2) an Alphabetical Index using the common names of the multimedia standards.

A Glossary, Appendix B; a List of Acronyms, Appendix C; and a List of References, Appendix D are also incorporated in the updated document.

Also at the end of the document is a form to obtain feedback or corrections to this revised *Multimedia Technology Standards Assessment* document. Merely fold the form and mail it back to the DISA/CFS imprinted address with your comments. Additional copies of this document can also be ordered with this form.

1.6 ACKNOWLEDGEMENTS

Current data and information assembled in this updated document were derived from many public and private sources. In some instances, for accuracy and clarity, verbatim text and graphics were obtained from these sources. Some were modified for currency. Every attempt has been made to ensure inclusions are attributed to proper sources as noted in the Reference Section of this document. Any misinterpretations or omissions are purely unintentional, and not intended to infringe upon the rights of any owners. All copyrights and trademarks are acknowledged to be the property of their respective owners.

Four principle sources merit specific recognition because they have a variety of publications regarding multimedia standards and generic information technology standards: (1) the Edinburgh University Computing Service (EUCS), (2) the Institute for Defense Analyses (IDA), (3) the R'eseaux Associe's pour la Recherche Europe'enne-Singel (RARE), and (4) the Interactive Multimedia Association (IMA). Other references are annotated specifically in the text or noted in the Reference Section of this assessment document.

1.7 SUMMARY

Many multimedia practitioners feel "The good thing about standards is that there are so many to choose from." Although intended as a disparaging comment, in the multimedia environment, the remark is factual. The reason there are so many standards is because there are multiple interfaces between components of a multimedia system, and each interface is a candidate for standardization. Consequently, for systems employing multimedia applications, multimedia standards compatibility is critical for interactive networking and platform interoperability.

The following principal standards criteria are emphasized throughout this document:

- Duplicate standards at the same interface carrying the same semantic information should be avoided
- Standards should specify semantics appropriate for the information being exchanged at the interface being standardized
- Each significant interface in a multimedia architecture, or reference model, must be addressed by an appropriate standard

A prevalent theme throughout this document is that multimedia is not simply defining new ways of presenting information. It also is expanding our knowledge and understanding of complex information transfer and interchange. Government and industry are increasingly using multimedia. Within DoD, interest is gaining momentum to provide multimedia information services to warfighters and battlefield commanders. Elsewhere in Government and industry, multimedia is helping the United States compete in the global marketplace by quickly providing important, easy-to-understand information to users worldwide. However, if multimedia is to be successful, it has to be sufficiently inexpensive, increase productivity, and provide an acceptable return on investment.

The phenomenon of multimedia is accelerating. Development of multimedia standards to support new applications will be based upon the pervasiveness of the technology and advances in information systems compatibility, portability, and interoperability. It is intended that this document will be revised as multimedia technology standards evolve.

2. MULTIMEDIA AND PORTABILITY

2.1 DEFINITION OF PORTABILITY

Portability refers to a characteristic of software, usually of application programs (similar to a multimedia authoring system) or systems utilities (similar to graph ics libraries or data format translators). Measures of portability express the ease of operating a piece of software on different computer platforms.

Portability is measured along a nearly continuous spectrum of possibilities. The most portable software is written in such a manner that it is independent of (1) host hardware (machine-independent), (2) peripheral hardware (device-indepen dent), (3) programming language(-independent), and (4) operating system (OS)-independent.

Portability is also measured by whether it refers to the binary incarnation of the software (e.g., the EXE or executable version, which has been compiled and linked), to the compiled but unlinked version (e.g., the OBJ or object version), or only to the source version (e.g., the uncompiled and unlinked version).

2.2 STATE-OF-THE-ART

Object and executable code portability are expected for software that runs on the same equipment and operating system. As differences in the operating environment are encountered (e.g., different operating system versions, different graphics cards, or different peripherals), it is more likely that object code and executable code portability will not be maintained, even across platforms made by the same manufacturer.

Cross-platform source-code portability is easier to achieve than object or execut able code portability, but it is still difficult to achieve fully. Traditionally, cross-platform source-code portability is obtained by carrying out two concurrent engineering activities:

- Specifying functions of a collection of services so peculiarities of the hardware, devices, and operating-system are hidden from the client application using the services.

- Specifying the application program interface (API) to these services in each of the programming languages of interest to developers.

The state-of-the-art today is that within single operating environments (Unix systems, PC-DOS, Microsoft (MS) Windows, IBM OS/2, and Macintosh systems) most programs can be written in a portable fashion. However, there is little or no portability for multimedia applications across different operating platforms. Formal standards for encouraging portable applications are already available for different services or are just emerging:

- **Standardized Programming Languages:** C, FORTRAN, and C++, provide basic arithmetic, control, and data structuring capabilities.

- **Standardized Graphics Programming Services**: Graphic Kernel System (GKS), Programmer's Hierarchical Interactive Graphics (PHIGS), and Computer Graphics Interface (CGI) provide a device-independent interface to present graphical information on a display or printing device and accept input from the operator of the program. There are also a number of *de facto* standards in this area.

- **Standardized Operating Systems Facilities:** Each operating system has its own API specifications, but there is little uniformity across operating environments. Portable Operating System Interface for Computer Environment (POSIX) is a Government-endorsed IEEE/ANSI/ISO effort to specify such an API. The major operating environments that multimedia applications are being developed for are Unix, MS/Windows, Windows/NT, Apple Macintosh, and NextStep.

- **Standardized Utility Services:** The IPI-PIKS (developed by X3H3 and SC24) provides a collection of procedures that operate on images. Filters, convolution functions, and arithmetic functions are a few of the several hundreds of imaging operations standardized by PIKS. The IIF-Gateway provides a collection of procedures that permit the importing and exporting of IPI-IIF encoded images and image-related data.

- **Standardized Access To Databases:** The ANSI and ISO standard is Structured Query Language (SQL). Extensions to SQL that enable it to support object-oriented databases (SQL-3) are being developed. In addition, SQL-Multimedia (SQL MM) is an ongoing project of X3H2 to provide support for multimedia objects contained in SQL databases.

Outside the formal standards development environment there are a number of activities that, if successful and adopted by industry, should help with portability of multimedia applications and utilities:

- The Interactive Multimedia Association (IMA) has issued a Draft Recommended Practice for Multimedia System Services (MSS) (May 1995). The Recommended Practice is based on a technology submission made jointly by IBM, Hewlett Packard (HP), and Sun Microsystems, Inc. The Draft Recommended Practice describes what is unique about multimedia data types, synchronization, and the implications for networks. The middleware defined in the Recommended Practice marshals lower-level system resources for multimedia data processing, including definition of a Media Stream Protocol to support independent transport and synchronization of multimedia data objects. A set of common services which can be used by multimedia application developers on an industry-wide basis is provided in a local call library.

- In another area, major operating environments have included capabilities for dynamic linking of libraries and conventions for cross-referencing (linking) of objects and the interchange of data across applications. A typical example is MS Windows, which has facilities called Object Linking and Embedding (OLE) facility and Dynamic Link Libraries (DLL). Unfortunately, there is no cross-platform agreement as to the APIs used to access these features, nor to the actual details of the behavior of these features. Some of the technology being developed by Object Management Group (OMG) may eventually provide cross-platform compatibility for application developers.

- IMA Recommended Practice for Data Exchange (July 1995) is based on Bento, part of the OpenDoc standard interchange format developed by Apple and Avid Technology's Open Media Framework Interchange (OMFI). The Recommended Practice defines a flexible file container format and framework for data exchange, providing a solution for moving large amounts of multimedia data - including graphics, animation, audio, motion video and text - among different computer platforms. The Practice supports two levels of data exchange that address the need to exchange discrete multimedia data types as well as multimedia data compositions which include audio, video, and/or graphics, thereby allowing developers to select the method of exchange that suits their needs.

Meanwhile, multimedia portability remains a serious problem. However, ISO SC24 has begun work on a formal project to specify a Presentation Environment for Multimedia Objects (PREMO). The goal of the PREMO project is to provide an object-oriented framework in which persistent multimedia objects, whose specifications conform to various national and international standards, can be constructed, accessed, presented, edited, stored, and interchanged among applications residing on heterogeneous platforms. PREMO is intended to support both distributed and nondistributed applications. PREMO will specify the common semantics for specifying the externally visible characteristics of PREMO objects in a platform-independent way. The IMA Recommended Practice for Multimedia System Services (MSS) is currently planned to become Part 4 of PREMO.

In addition, MIL-STD-1379D is an attempt to increase portability of DoD-based interactive video. IMA has upgraded their "Recommended Practices for Multimedia Portability" (RPMP) for DOS-based interactive courseware (ICW) delivery systems. Enhancements to Release 1.2 include support for super-VGA graphics and digital audio. Three new service groups have also been added to support waveform, MIDI, and compact disc audio.

2.3 SUMMARY

Although economics has placed renewed emphasis on software reuse and interoperability, multimedia applications continue to resist portability. However, international work is ongoing to provide an object-oriented framework for porting applications in a platform-independent manner (ISO SC24). The most promising is PREMO. If successful, ported multimedia objects will conform to national and international standards. Additionally, end users rarely notice portability directly, except when it doesn't function correctly. However, the more portable the application development environment, the more likely an end user's favorite application is available. In the eyes of the press and the general public, portability as a standards issue has been much less visible than data interchange, file formats, and publishing (delivery) formats.

3. MULTIMEDIA AND INTERCHANGE

3.1 DEFINITION OF INTERCHANGE

Interchange refers to the transferring of information between processes (e.g., applications or services). Interchange can be successful only if both parties to the interchange transaction (the sender and the receiver) have knowledge about the format of the information being interchanged. The interchange can be blind, meaning that interchanged information must be self-describing to some extent (e.g., the Society of Motion Picture and Television Engineers [SMPTE] head er/descriptor approach), or negotiated, which infers that the sender and receiver carry on a dialogue to determine common formats to exchange information success fully (e.g., many OSI network services).

Information can be exchanged at several semantic levels. The simplest level is called a monomedia format or data format. A data format represents one type of information. The data types of interest in the multimedia domain include text, geometric graphics, raster graphics (including still images), moving images (including animations and analog and digital video), and digital audio. All data types are represented in some type of encoded form. The encoding may be simple (e.g., the 7-bit ASCII code for text) or complex (e.g., Motion Picture Expert Group -- (MPEG) motion prediction). Data formats may be interchanged directly or embedded in more structured interchange files or data streams. Collections of monomedia objects may be wrapped in a container file (such as Bento, a format proposed by Apple to the IMA). Relationships among the objects in these files (e.g., synchronization information) may be shown by providing further information, sometimes called an exchange set description.

Another layer of structuring may be provided by using or providing a direct mapping onto the file system of OSs. Such features of file systems as directories, subdirectories, and files may have direct application on transmission media (e.g., tape, floppy disk, CD-ROM, or more recently, CD-Recordable ROM [CD-R]). CD-R is designed to grow rapidly as a subset of document management. The fact that CD-R is a high-volume (each disc holds 650 MB), low-cost storage medium that operates according to accepted industry standards (ISO 9660) will contribute to its growing acceptance in the marketplace.

3.2 STATE-OF-THE-ART: DATA FORMATS

Table II shows the formal and some *de facto* standards available for each principal data type that relates to multimedia applications. Standardization issues associated with each of the data types are discussed below:

Table II. Data Formats and Related Formal and *De Facto* Standards

DATA FORMATS	FORMAL AND *De Facto* STANDARDS
Text ISO 646, 2022, 8879, 10646	RTF, SGML, PostScript, SPDL, HTML, SMDL
Vector Graphics	Computer Graphics Metafile (CGM) PHIGS Archive Files, IGES, DXF, STEP, GKS
Raster Graphics	TIFF, GIF, PNG, PICT, MacPaint, MS/Windows, and X Windows bitmap IPI-IIF (Image Interchange Facility) JBIG, JPEG, CCITT/ITU group 3 (T.4) and group 4 (T.6) fax OD part 7 and CALS tiled raster
Mixed Text Graphics	CGM, PICT, PostScript, SPDL
Analog Video	ATSC A/53; NTSC, PAL, SECAM, MIL-STD-1379 ITU-R 624, HDTV: ITU-R 709 HDTV: SMPTE 240M, EBU 3271
Digital Video	MPEG-1 Video, MPEG-2 Video ITU-T Rec. H.120, H.261 D-1, D-2, D-3, D-5 ITU-T 601, ITU-R 656 HDTV: SMPTE 260M, EBU 3271
Digital Audio	IMA Recommended Practice ITU-T G.711, G.722, G.726, and G.728 CD-ROM-XA audio; CD-DA; MIDI MPEG-1 Audio, MPEG-2 Audio
Mixed Digital Video and Audio	MPEG-1 System, MPEG-2 System ITU-T H.20, H.320, and T.120 series Intel's DVI and Indeo Apple's QuickTime, Philip's CD-I Sony's CD-ROM-XA, Avid's OMFI, and Microsoft's Video for Windows

The Red Herring, MUNE, 1994 (Modified)

Text. Most text can be interchanged successfully at the character code-level. An entire series of ISO standards (646, 2022, 8879, 10646, and 9541) provides an interchange of most international orthography. However, special symbols (e.g., copyright symbol, bullet characters) are not as well standardized. For example, only a few commercial products support ISO Standard 9541, (e.g., font, point size, glyph metrics, appearance -- bold, italic). *De facto* standards such as the Adobe Type 1 fonts and the Microsoft TrueType fonts provide some fidelity when text is interchanged, but applications and printing devices vary greatly in their support of these collections of fonts.

UNICODE is an effort to combine all ISO-supported glyphs along with many specialized glyphs (such as those in the IBM PC character set) into a single, multi-byte character code. UNICODE has not been formally accepted by ISO, although efforts are underway to harmonize ISO work with the consortium-led UNICODE effort.

Another text-related format is represented by the Microsoft Rich Text Format (RTF) consisting of a tagged data stream of characters. The tags indicate both structural information (e.g., paragraphs) and presentation information (e.g., fonts, appearance, underline).

Vector Graphics. The principal formal standard that encodes vector graphics information (filled areas, lines, graphics, text, and symbols) is Computer Graphics Metafile ([CGM]--ANSI/ISO 8632; FIPS 128). CGM is widely supported in numerous PC- and Unix-based applications (word processors, presentation graphics, and graphics libraries). CGM is included in recommended practices of several industry-specific consortia, including the DoD Continuous Acquisition and Life-Cycle Support (CALS) program, the Petroleum Industry Profile (PIP), and the Airline Transport Association (ATA). CGM also provides the basic vector graphics capability for the Office Document Architecture (ODA--ISO 8613).

Part 2 of the PHIGS standard provides an archive format for 3D graphical objects, and the IGES standard (ANSI Y14.26M) includes elements that permit specifica tion of graphical pictures. This latter standard is intended for the representation of product model data such as contained in drawings produced from computer-aided design/computer-aided manufacturing (CAD/CAM) systems. There are a few commercial, *de facto* standards (e.g., Apple's PICT format and Autodesk, Inc's DXF format), but 3D formats are lacking in both formal and *de facto* standards.

Raster Graphics. During the past 11 years, literally hundreds of raster graphics formats have been designed and introduced to the marketplace. However, during this period, no formal standards for raster images were developed. Consequently, in the mid-80s and early 90s, graphics and imaging applications had different formats. In 1993, the marketplace's rising interest in digital video and imaging in multimedia products began to reduce the number of interchange formats. TIFF, the MS/Windows and X Windows Bitmap format, and the Apple MacPaint format are some of the surviving dozen or so *de facto* standard formats used today. GIF, formerly a *de facto* standard, is being replaced by the new Internet PNG standard.

ISO JTC1/SC24, with the Image Processing and Interchange (IPI) Image Interchange Facility (IIF), and ISO JTC1/SC29, with JBIG and JPEG, have recently developed standards that address monochrome, gray-scale, indexed color, and direct color (full-color) raster images. The SC29 standards concentrate on complex encoding schemes that sometimes achieve compression rates of greater than 10:1. For example, both lossless and lossy schemes are present in the JPEG family of algorithms (see Chapter 10). With the advent of JPEG compression/decompression (CODEC) chips and efficient software-only implementations, JPEG is widely used to interchange still images in multimedia systems, especially those operating over low- and medium-speed networks (e.g., Ethernet).

Another group of early formal standards were the ITU-T group 3 fax (T.4) and group 4 fax (T.6) recommendations. These standards support only bilevel (1 bit per pixel) coded images. Several tiled raster standards, including the CALS raster specification, are based on the ITU-T fax standards. Their main advantage lies with their compatibility with low-cost facsimile equipment. However, their many disadvantages (a few fixed resolutions, no color) renders them unsuitable for general use in multimedia applications. In the future, service for T.4 will remedy these deficiencies by including JPEG, which ITU-T calls T.81.

Mixed Text and Graphics. Both the computer graphics metafile (CGM) and PICT, as well as Adobe's PostScript and the related ISO Standard SPDL, permit mixing text with graphic data. However, they do not support sophisticated compression methods and are not widely used for large or complex images. Nevertheless, there are probably many simple situations where the CGM could be used. A minimum CGM containing only raster images is no more difficult to read than an equivalent tagged image file format (TIFF). The future ISO standard IPI-IIF will allow inclusion of CGM files.

Analog Video. Most video occurring in multimedia applications is digital. However, it is still possible to find analog video, using one of the three worldwide color TV standards (NTSC, PAL, or SECAM) in multimedia data streams. MIL-STD-1379D is a successful standard for training applications as it directs storing video sequences as analog video suitable for display on PCs with VGA resolution.

The video technology incorporated in this DoD standard is contained in an IMA Recommended Practice.

Digital Video. The PC and workstation market have been in turmoil regarding standards for full motion video delivery and multimedia playback. Early attempts to provide solutions resulted in proprietary solutions that were either limited to a specific hardware platform, expensive to implement, delivered less than acceptable quality video, or created royalty and license issues for the user. Now this is one of the fastest growing areas of data format standardization.

Early efforts were media-specific; however, the movie and TV advertising industry, through SMPTE, developed a number of high-quality studio standards, including D-1, D-2, D-3, D-5, and digital Betacam. The video conferencing community, through the ITU-T, developed Recommendation H.261.

More recently, different standards and recommendations for High-Definition Television (HDTV) have been developed or are undergoing standardization. HDTV includes 16:9 aspect ratio, about twice the standard TV resolution, and improved color and audio fidelity. ITU-R 709 is the base for all developments in the U.S. and Europe. In Europe, EBU 3271 is the current studio HD standard. In the U.S., SMPTE 240M and 260M are the studio analog and digital standards. Currently, a family of transmission standards for HDTV is being developed by several groups of the Federal Communications Commission (FCC). The Advanced Television Systems Committee (ATSC) recently issued its HDTV standard (ATSC A/53).

In the computer and information processing community (ISO JTC1/SC29), the effort is focused around the Motion Picture Expert Group (MPEG). The initial MPEG specification (ISO/IEC 11172) is designed to deliver digital video data on CD-ROMs at up to 1.5 megabits per second (MB/s). The MPEG-1 technique allows 70 minutes of compressed video and audio to fit on a CD-ROM. The MPEG-2 main profile was defined to support digital video transmission in the range of about 2 to 15 MB/s. MPEG-1 overcomes two problems previously encountered in trying to place video on CDs: capacity and bandwidth. This multi-part standard (MPEG-2) is essential for the next generation of digital television, high-definition television, and a host of other video-related services. This action by the technical committee X3L3, the U.S. Technical Advisory Group to ANSI for audio-visual coding, sets the stage for the standard's worldwide adoption by early 1995. The MPEG-2 standard will be formally known internationally as "ISO/IEC 13818 Information Technolo gy." MPEG-2 video and audio decoders are also capable of decoding and playing MPEG-

1 (ISO/IEC 11172) bitstreams. Different levels (resolutions) and profiles (features) will be included in the MPEG-2 toolkit.

According to David Berlind's *Reality Check* article in *PC Week*, 9 January 1995, "Regardless of whom I talk to about standards, videoconferencing, and ATM, one API that is currently being designed has cropped up repeatedly: the API for running MPEG-based motion-video streams on an ATM network." Later in the same article, Mr. Berlind states, "...it seems the future is pointing to MPEG. Whether it emerges as the de facto standard remains to be seen. At the very least, its impending predominance should be a warning to buyers about protecting their investment."

Digital Audio. Formal and *de facto* audio standards abound (see Table II). Eight of the more popular public formats were specified in the IMA Recommended Practice for Digital Audio. Several algorithmic approaches are included, as are encodings of both mono and stereo channels. Some of these recommendations are based on ITU-T recommendations G.711 and G.722. The main *de facto* standard not represented in the IMA Recommended Practice is CD-ROM-XA audio, whose technology is owned by Sony. Licensing and other intellectual property con straints prevented including this widely used audio format.

More recently, MPEG audio is being promoted as a versatile, robust format, and the first CODEC chips have been prototyped. MPEG audio includes different quality levels with different sampling rates and compression ratios. MPEG encoders compress audio and video using a single system clock. Source material can be fed to the encoder board via balanced audio or from a sampled digital source. The result has been the creation of multimedia programming that has true "lip sync." The ISO specification for MPEG audio is ISO 11172-3, Layer 2.

Mixed Digital Audio/Video Data Streams. The MPEG, DVI (Intel's Digital Video Interactive), CD-ROM-XA (Sony), CD-I (Phillips), and QuickTime (Apple) specifications all include the ability to interleave audio and video data streams with implied synchronization. However, only the Open Media Framework Inter change (OMFI) specification (see discussion under File Formats below) permits the arbitrary positioning and synchronization (called composition by the OMF) of audio and video clips within a single data stream. The recently released Pentium 75-Mhz chip is a major breakthrough and supports both audio and full-motion video data streams. Additionally, Microsoft's alternative to QuickTime to show video in a window is Video for Windows.

Electronic Data Interchange (EDI) in CALS. The CALS initiative is one of the largest and best known EDI proponents. CALS required full compliance to EDI standards for digital delivery of technical information and interoperability among DoD systems in 1990. Major applications areas are automation of techni cal manuals, computer-assisted design, and spares acquisition. CALS standards include EDI for data interchange file management, IGES for engineering drawing, Standard Generalized Markup Language (SGML) for automated publishing, and CGM for technical manual illustrations. The standard currently used for raster graphics representation is US DoD-unique (MIL-PRF-28002B, 14 December 1992). Potential CALS EDI multimedia standards applications are:

- **MIL-HDBK-59B,** ***CALS Program Implementation Guide*** (June 1993) helps weapon system acquisition managers understand when, where, and how to apply CALS capabilities efficiently to support their information interchange and access requirements. It also helps define functional requirements for integrating the contractor's pro cesses (such as reliability and maintainability analysis) and creating and using the information.

- **MIL-STD-974,** ***Contractor Integrated Technical Information Service (CITIS), Functional Requirements*** (Fall 1993) implemented DoD's new CALS acquisition standard giving preference to con tractor information services and on-line access rather than deliver ables and generally how DoD will buy information services. It de fines things a contractor must do, such as planning, analysis and submitting proposals, and things the Government must do, such as managing data and providing access to data tailored to meet a speci fied concept of operations (CONOPS).

Current EDI concerns are aspects of data transfer, in particular the interface between EDI applications and communications protocols in open system environ-ments. The requirement for full-motion, full-picture video is stimulating research in this area.

CALS and MIL-HDBK-SGML. This is a new SGML user's handbook that supports MIL-PRF 28001B SGML applications. The handbook contains a tutorial on SGML and provides explana tions of SGML applications used for DoD CALS. The handbook provides guidance on analyzing document data and on how to determine "tagging" schemes to use to create a Document Type Definition (DTD). It gives further guidance on appropri ate tag-naming conventions.

The handbook also contains instructions on how to use the MATHPAC for tagging equations/formulas, table tagging, and the use of electronic review tagging for documents. The handbook will allow information such as SGML tutorial text, an example DTD, and the tag-set descriptions to be removed from MIL-PRF-28001B since that information is now in the new handbook.

3.3 STATE-OF-THE-ART: CONTAINER AND FILE FORMATS

Groups of monomedia that are related in some manner can standardize storage and transmission (interchange). When the additional structure is purely syntac tic and does not impose a rigid hierarchy among data "chunks," these "higher-level" files are called container files. When the structure also has some implied meaning--that is, semantics--or imposes certain types of relationships among the data "chunks," the reference is to file formats and exchange set descriptors. It is difficult to precisely classify each standard clearly, and some *de facto* standards span several levels.

For example, Bento is a pure container format that permits any type of data chunks to be escorted within a single data stream or file. Bento supports a wide variety of relationships among the data chunks. As an emerging *de facto* standard, Bento was specified by Apple and other partners. Bento is gaining support and has been included in the IMA Recommend ed Practice for Data Exchange.

IMA Recommended Practice for Data Exchange is also based on Avid Technology's Open Media Framework Interchange (OMFI) which includes Bento, but adds another level of information. OMF permits the specifier of a file to indicate transitions between sequential digital video clips (data chunks in the file) and supports synchronization of several data streams, which are expressed with OMFI. This support for time-based "composition" is not found in many file formats.

Conversely, some formats are more specific and usually more rigid. Two DoD sponsored efforts to formalize details of a multimedia data stream are: (1) MIL-STD-1840, which specifies the format of a CALS tape deliverable, and (2) the National Imagery Transmission Format Specification (NITFS), which specifies the format of a specific datastream for representing an overlaid frame potentially containing text, graphics, image, and symbol data. There are also other special ized file formats for interchange created by the Government and other Govern mental and commercial groups: e.g., the LANDSAT Thematic Mapper Tape Format.

3.4 STATE-OF-THE-ART: MESSAGE FORMATS AND SERVICES

For interactive, two-way information exchanges, the format of messages on top of some network services has been specified by some working groups. These message formats and services usually do not invent new data formats for the basic data types. Instead, they allow use of other industry formal and *de facto* standards for data chunks appearing in their messages or otherwise being transmitted over the network. Two examples are the Multipurpose Internet Mail Extensions (MIME) message specification and the X.400 and X.500 services:

- The MIME message specification is an emerging Internet standard for electronic mail (email) containing multimedia data.

- The X.400 and X.500 services, developed jointly by ISO SC21 and ITU-T, are service definitions supporting multimedia E-mail and directory services for the ISO/ITU-T Open System Interconnect (OSI) environment.

3.5 SUMMARY

Data formats allow interchange of monomedia information (sound and video clips, still images, etc.). File formats allow information that is more structured and is capable of showing relationships among the data formats. Many data format and file format specifications contain auxiliary information that permits some meaning to be deduced from the interchange of formats. However, most interchanges of data and files do not lead to pure interoperability without extensive information being exchanged or without agreements between sender and receiver--agreements negotiated outside the mechanics of the interchange of files and data formats. Standards are needed.

4. MULTIMEDIA AND INTEROPERABILITY

4.1 DEFINITION OF INTEROPERABILITY

Interoperability is the successful interchange of both data and meaning by both originator and receiver. Two application processes are said to interoperate when the output of one process is successfully acquired and successfully used by the second process. There are many examples where commercial programs actually interchange data (through bitmap-based clipboards, raster file formats, etc.), but few examples where true interoperability is achieved.

General-purpose standards to support interoperability are complex and comprehensive. Usually such standards rely on other standards, or families of related standards, to provide true interoperability. Attempts to achieve interoperability are typically undertaken by application-oriented groups (e.g., in electronic publish ing, medical imaging, or electronic commerce).

Official definitions of interoperability from the Joint Chief of Staff (JCS) Publication 1-02 are:

For DoD - "The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases."

For DoD and NATO - "The ability of systems, units or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together."

4.2 STATE-OF-THE-ART: DOCUMENT ARCHITECTURES

The ISO and ITU-T standard Office Document Architecture (ODA) is the first major effort to specify both the content and structure of electronic documents in a platform-independent way. The current standard (ISO 8613) supports the inclusion of bilevel raster images (based on fax standards) and color geometric graphics (based on the CGM standard). ODA has had some success in Europe, especially among the large PTTs, but ODA is not well known or widely implement ed in the United States and has therefore does not appear in this document.

The ISO SGML was developed almost in parallel with ODA. SGML provides a syntax for tagging and grouping items in an SGML document. When used with an appropriate DTD, an SGML document can be mapped into the logical content and structure of an electronic document, with paragraphs, footnotes, tables-of-content, etc. When supplemented by a specification prepared using the Document Style Semantics Specification Language (DSSSL), an author can designate the suggested appearance of the actual layout of the document and the characteristics of the text (e.g., bold, italics, underlining, indentation of paragraphs).

Emerging standards in this same general area include HyTime which provides time-based synchronization and other capabilities required for true multimedia documents to SGML and ODA and the Standard Music Description language (SMDL).

4.3 STATE-OF-THE-ART: APPLICATION-SPECIFIC EXAMPLES

Numerous organizations sponsor specific application-oriented standards, which in turn provide end-to-end interoperability for that application community. Two examples are Open-EDI and American Council of Radiology-National Equipment Manufacturers Association (ACR-NEMA).

Open-EDI. Open-EDI refers to EDI among autonomous parties using public standards that strive towards interoperability. Interoperability is obtained by agreeing on standard messages, which are formal specifications that describe the structuring of data to enable transfer and handling of the data by electronic means. Examples include the messages needed to interchange an invoice, a bank transfer, or a credit card transaction. An interagency working group for coordinated, Open-EDI standards development (the IAEG) sponsored by the ISO/IEC, IEC, ITU-TS, and UN/ECE is an attempt to manage, monitor, and guide all aspects of Open-EDI in a way that minimizes the risk of widely diverging approaches to interoperability.

ACR-NEMA. ACR-NEMA has specified a specific raster image file format for interchanging medical images such as X-rays, MRI, and CAT scans. Because nonmedia-specific data needed by applications are included (patient's name, referring doctor's name, exposure information, etc.) this standard is effective in providing interoperability for applications that support the DICOM (formerly, ACR-NEMA) format and content. Some health-care multimedia systems try to accommodate the ACR-NEMA format, but do not have enough specific image information to serve as a general-purpose, uncompressed raster image (still image) format.

4.4 SUMMARY

A rich interchange format can lead to interoperability if the exchanging application processes are both functioning at the same semantic level. Matching semantic levels is crucial in multimedia interchange. Problems arise when a low-level data format is selected as the transfer syntax. This leads to information being lost when the internal data structures are sent to the data format. When the receiving application processes this information, most of the information is lost. The receiving application has little opportunity to manipulate the received information and certainly not at the level available to the sending application. Interoperability standards must be designed carefully to retain the appropriate amount of semantics needed to truly interchange applications data.

5. MULTIMEDIA AND AUTHORING

5.1 DEFINITION OF AUTHORING

Authoring is the name given to the process of creating a multimedia application or "title." Several distinct skills and resources are needed when authoring: curriculum development provided by a subject matter expert (SME); content (video, still images, audio obtained from outside sources or created); interface design (provided by human-computer interaction specialists), and production techniques (provided by those skilled in the technologies of bringing an idea to "digital reality"). Good authoring systems enable individuals to jointly produce a multimedia document or title in a common development environment.

Aside from the obvious impact of data and file format standardization, there are two distinct areas where standardization could favorably affect authoring systems: (1) standardize the user interface so authors could easily move from one authoring system to another without excessive retraining and (2) standardize the representation of the authored title or multimedia document so representation can be used by different multimedia playback systems.

5.2 STATE-OF-THE-ART: STANDARDIZED USER INTERFACES

Little formal multimedia user interface standardization work is ongoing. User interface specialists believe that new user interface metaphors; new paradigms; new hardware, voice response, and voice recognition; handwriting recognition; and touch interfaces are still evolving rapidly. Users conclude that it is premature to standardize at the user interface.

On the other hand, many business users and noncomputer professionals are frustrated by the seemingly arbitrary differences among applications and operat ing environments. This is what the "operating system wars" are all about. Because most operating environments come with a closely associated graphical user interface (GUI), e.g., DOS with Windows, Unix with OSF/Motif, and Apple System 7 with the Macintosh User Interface (UI), those who operate within a single OS environment acquire benefits derived from a common GUI and interac tion paradigm. This creates intense loyalty that OS-suppliers exploit.

Nevertheless, as GUIs like OSF/Motif, Windows/NT, and NextStep are rewritten to be independent of (or only loosely coupled to) underlying hardware platforms, it will be possible to have a GUI of choice available on the hardware of choice. This is not the case today. The *de facto* company and consortia standards noted above are initial attempts to provide cross-platform user interface standardization.

The Government and IEEE are drafting specifications that indicate recommendations and guidelines for interaction (e.g., what type of buttons should be used for what type of selection operations). However, these specifications do not standard ize full details of the user interface. At the supplier level, companies that offer a family of products often develop internal standards for the user interface that enable individuals familiar with one of the company's applications to use another.

5.3 STATE-OF-THE-ART: STANDARDIZED DOCUMENTS AND TITLES

The output of an authoring process is a multimedia title or document. The result will typically be used in one of three ways:

- As input to a more complex authoring program
- As a delivery format
- As a "master" from which the delivery format (the one used by the player) is produced

For most document architectures described in the previous chapter, extensions to support multimedia data types are being developed. For example, SGML already permits the inclusion of external references to files, which can be various monomedia data formats like TIFF or CGM files. HyTime would add time-synchronization and other multimedia document capabilities to SGML. Similarly, ODA already includes raster and CGM objects in a document, and HyperODA would add the requisite multimedia capabilities to ODA.

In addition to these office-system-oriented standards, another family of scripting standards is being developed by formal committees, consortia, and private companies. Scripting language expresses the author's plan for playing out the entire multimedia title. Scripting language must contain sufficient linguistic expressiveness to specify various types of output informa tion: ***which*** audio clip or video clip or still image to display ***where*** on the screen at ***what time*** and synchronized with ***which other*** elements. Furthermore, good scripting languages must support interaction with the user of the title and make the playback conditional upon user inputs.

Authoring systems are the application packages that developers often buy to develop courseware. Quest, both the DOS version and the new Quest for Win dows, and IconAuthor are typical examples of authorware. In addition, there are a set of tools such as Asymetrix' Toolbox or even Visual Basic that do not include the instructional underpinnings present in the "authoring systems" but are commonly used to develop courseware.

Authoring is the most time-consuming component of disk creation and can consume 80 percent of the development effort. The recent development of CD-Recordable (CD-R) technology appears to be a viable "do-it-yourself" method of cost-effectively producing CD-ROMs on-demand, in-house. In a 1994 study, Doculabs, Inc., in association with the University of Illinois, Chicago (UIC), conducted a technology assessment of various CD-R disk authoring processes. Four products were analyzed and the results are summarized below:

- **Acrobat: Version 2.01A:** Adobe has spent much time improving Acrobat's usability. Text and images can be easily incorporated; images and their refresh rates have good compression. Authoring times are quick. However, the data preparation process is inefficient: all files (text, image, spread sheet, or any combination) must be converted into Acrobat's Portable Document Format (PDF) to be authored. Also, Acrobat's files are noneditable. To change a document, you must go back to the source docu ment, make the change, and repeat the entire process. Consequently, files put into Acrobat should be in final form, proofread, and ready to be authored. Best applications of Acrobat are reports, presentations, and electronic publications.

- **Alchemy: Version 2.01:** Alchemy can claim first rights to the idea of using CD-R for archival. Alchemy has two major attributes: (1) indexing and file compression algorithm and (2) automatic batch indexing for images that automates the indexing (or "profiling") of scanned images. In the first case, files are indexed and compressed into one large file. Retrieval from CD-ROM is under 3 seconds from an index and compressed to three to four percent of the size of the original data. The second attribute permits including thousands of images in one index identifier "profile," or entering key fields for specific pages. These attributes make Alchemy an efficient tool to spread data across several CD-Rs, perhaps in a jukebox. Best applications are human resource documents, specifications, and mainframe data.

- **Dataware: Version 3.21:** Dataware is the only company that sells a complete line of products for the CD-ROM world: structured data authoring, text authoring, premaster, and writers. The structured data product is one of the fastest products on the market. Authoring consists of converting a "database" of information into a proprietary format. Once converted, it cannot be edited or changed. Therefore, Dataware is ideal for authoring data only a few times a year. Dataware feels its product is still worth $30,000. Best applications for Dataware are catalogs, technical manuals, and mainframe data.

- **Folio: Version 3.0:** Folio is a "true" publishing software package. Folio enables authors to edit data files in an infobase similar to using a native word processor. A "Pro-Publish" module allows files to be linked over a network and copied onto the local drive with all network files updated automatically. However, navigation is poor inside an infobase with many images, as they are automatically scaled down to approximately 75 percent, which could represent a limitation for some applications. If the intent is to simply author pages of text, Folio is strong in this area. Best applications for Folio are desktop publishing, reports, and user manuals.

The Standard Multimedia Scripting Language (SMSL) is a project within ISO/IEC JTC1/SC18. Gain Technology Extensions Language (GEL) and ScriptX (from Kaleida Labs) are two privately-developed languages. Telescript, a new development, is being privately developed by a new company called General Magic. Little is known about Telescript, but its goal is to do for multimedia presentation what PostScript did for desktop publishing. All of these specifications are designed to be platform independent (that is, specified in a manner that by reading the format interpreters can be developed for any CPU and device hardware configuration, running any operating system and multimedia support services).

5.4 SUMMARY

Authoring is a multimedia application that produces a special output. The output is expressed as a file that can either be interpreted directly by multimedia playback systems or used as an interchange format (or collection of files) transformed into the delivery format used by the playback systems.

There are several contenders for such a platform-independent scripting language. None is widely used today. Instead, today's authoring systems typically either write directly to a delivery format (see next chapter) or produce groups of files that have to be manually edited into the delivery format by further software- and hardware-assisted steps. Creating multimedia standards to specify the interface to authoring systems and the interface between authoring systems and other multimedia-based systems will be an active area in the next several years.

6. MULTIMEDIA AND DELIVERY

6.1 DEFINITION OF DELIVERY STANDARDS

Standards for multimedia delivery specify file formats for physical media (delivery systems) which will be read by the system on which the multimedia title is played or presented. Also, for systems using multimedia titles, a delivery standard can specify the input language to be used in designing a network's architecture. As described in the previous chapter, a delivery standard may also serve as the output language of the authoring process.

6.2 STATE-OF-THE-ART: MEDIA-DEPENDENT FORMATS

Most delivery formats today are closely tied to the media on which they are delivered. Examples are:

- Digital Audio Tape (DATs) similar to, Sony MiniDisk and Phillips Digital Compact Cassette (DCC).

- Video tape recorder (VTR) formats similar to VHS, S-VHS, Hi-8, Betacam, D-1, D-2, D-3, D-5, and digital Betacam.

- Videodisk (laser disk) formats such as are specified by MIL-ST D-1379D for delivery of DoD training applications.

In 1980, Sony and Phillips released the first specifications for music compact disks, a new media first used for digital audio recordings. The specifications defined both the physical specifications of the media and the logical specifications of how bits were to be positioned around the circumference of the CD disk to be read by laser.

Over the years, different CD formats have been jointly defined by Phillips and Sony in a set of specifications, each having a different color cover. In addition to specifying how to lay out audio tracks or raw computer data (which could be interpreted as raster images or digital video), later books specify how mixed format (audio and computer data) CDs can be constructed. In 1986, ISO 9660 overlaid a standard file format (with files, directories, and volumes) onto the so-called CD-ROM, Mode 1 format specified by the Yellow Book. This has become the *de facto* CD-ROM computer standard.

In 1987, ISO 9660 was extended to apply to CD-ROM, Mode 2, Form 1 (as specified in the Green Book). More recently, in 1992, Kodak adopted CD-ROM-XA, Mode 2, Form 2 (multisession) to be the media format for its proprietary color image delivery system, called PhotoCD. Each of up to about 100 PhotoCD images is stored in 24-bit color resolution in compressed form at five different spatial resolutions. The sequence of specification books, with related media-specific technologies, are:

- CD-DA (Digital Audio, Red Book in 1980)
- CD-ROM (Read-Only Memory, Yellow Book in 1984)
- CD-WO (Write-Only, Orange Book in 1993)
- CD-I (Interactive, Green Book in 1987)
- CD-ROM-XA (Extended Architecture in 1989; with Microsoft)
- PhotoCD (Kodak's CD format for digital images)
- CD-ROM-R (Writable; just being developed)
- CD-HD (High Density, Gold Book; just being developed)

Each format requires its own player. The players in general are inexpensive and targeted at the consumer electronics and home-PC market. However, consumers are frustrated at the diversity of formats and the resulting incompatibilities.

6.3 STATE-OF-THE-ART: MEDIA-INDEPENDENT FORMATS

To minimize problems of interchange and interoperability, title producers prefer a single delivery format for distributing their titles. This would minimize produc tion costs and maximize market opportunities.

However, general-purpose playback systems capable of handling a variety of application demands have been too expensive until now for the consumer and home-PC markets. The central processing unit (CPU) and memory demands have been prodigious. Nevertheless, in the business world, precursors of such media-independent formats have been used for years.

Among the first examples are Page Description Languages (like HP's HPGL and later PCL) for desktop graphics and desktop publishing. Adobe's PostScript (which served as the base for the ISO Standard Page Description Language [SPDL]) is fairly device-independent across a spectrum of raster imaging devices like laser printers and phototypesetters. PostScript is strong with text data types and adequate with raster images, but it is weak with geometric graphics and does not support audio or video.

More recently, the Multimedia/Hypermedia Expert Group (MHEG) of ISO/IEC JTC1/SC29 is specifying an encoding of a data stream that encapsulates a multimedia document. MHEG has not been well coordinated with either the Multimedia/Hypermedia architecture work of SC18 or the PREMO work of SC24. Assuming these ISO projects can be coordinated, a good media-independent multimedia delivery standard will emerge. A European Programme for Research in Information Technology (ESPRIT) project, Open MHEG Architecture (OMHEGA) aims at specifying and validating a generic system architecture based MHEG. Preliminary results are expected in 1995.

Meanwhile, Kaleida's ScriptX is the most likely candidate for acceptance as a general-purpose, media-independent delivery format.

6.4 SUMMARY

Delivery of multimedia titles and data streams is critical to the market growth of the multimedia industry. Until recently, most titles were delivered on quasi-proprietary, media-dependent formats similar to videodisk and CD-ROM. This results in a fragmented market, duplication of hardware resources and expenses for mastering, and customer frustration. Wide acceptance of multimedia-enabled applications cannot occur until a media-independent delivery format is specified by a consensus body like the International Standards Organization (ISO), used by title producers, and supported by consumer electronic and computer industry hardware manufacturers. Technology advances in VLSI, Digital Signal Processors (DSPs), memory compaction, low-power consumption, and other areas, indicate that such an accepted standard will be available within the next 3-5 years.

7. MULTIMEDIA AND PLAYBACK

7.1 DEFINITION OF PLAYBACK

Standards for multimedia playback specify interface requirements to be satisfied by the equipment that reads the delivery format and produces output for the user. In an interactive application, there is also an input data stream of commands and actions that flows from the user to the playback program.

There are a number of levels at which such standards operate. At the physical hardware and electronics level, there are many industry standards developed by IEEE, ISO, IEC, and others (e.g., SCSI interfaces, NTSC composite video, and RS-232 connectors). They apply generally to computer and consumer electronics and are not particularly driven by multimedia considerations. At a higher level, playback standards can be divided into those that relate to particular devices, or families of related devices, and those intended to be device-indepen dent.

7.2 STATE-OF-THE-ART: DEVICE-DEPENDENT STANDARDS

In 1991, Microsoft and many of its hardware and software upgrade kit vendors formed the Multimedia Marketing Council (MMC). To provide consumers guid ance, the Council specified minimum hardware and system software requirements for a Level-1 Multimedia Personal Computer (MPC). Software title suppliers were then permitted to use the MPC trademark if their applications would run on minimally configured MPC platforms. This program has helped consumers replace confusing questions such as how much memory, what graphics card, how much hard-disk capacity, and which speed CPU with a single question: "Is it MPC Level 1?"

The price for Level-1 computers in 1991 was about $2,000. In 1994, an entry-level multimedia upgrade package costs between $300 to $450 (retail price). However, title producers wanted to write to a more powerful platform. Consequently, the MMC developed MPC-2, a new specification that is expected to remain current for 18 months (1995-96), approximately the same period for the original specification. The new specification is designed with software *full-motion video* in mind. Test suites and a certification program are planned by the MMC to add to consumer confidence that software products showing the MPC logo are compatible with hardware products showing the same logo.

Level-2 MPCs should include:

- 25 Mhz 486SX or compatible microprocessor
- 4 MB of random access memory (RAM) (8 is recommended)
- 3.5" high-density floppy drive
- 160 MB hard drive
- 16-bit sound
- CD-ROM drive; double speed, XA ready, multisession
- Display resolution of 640x480 with 65,536 colors (16-bit color)

The surge in titles over the past 2 years has resulted in a corresponding surge in multimedia hardware sales. According to InfoTech, a market research company, there were 4,588 CD-ROM titles worldwide as of October 1994. Of these, 1,301 were multimedia titles. As more computers are available with sound boards and CD-ROM drives as standard equipment, the term "multimedia PC" is becoming redundant.

In January 1995, the Assistant Secretary of Defense (Command, Control, Communications and Intelligence) issued a Draft Memorandum on DoD Mini mum Desktop Configurations which included multimedia extensions.

7.3 STATE-OF-THE-ART: DEVICE-INDEPENDENT STANDARDS

Only a few device-independent standards encouraging the portability of applications that playback multimedia titles are currently in use. Musical Instrument Digital Interface (MIDI) is an interface specification for electronic music synthesizers and sound boards. By using the MIDI industry standard, software developers are isolated from peculiarities of hardware used to make music.

In a similar fashion, multimedia applications operating over distributed networks and using bit-mapped graphics cards as their display obtain a degree of device-independence by using the X-Window Data Stream Definition as a device control and graphics input/output protocol. The X protocol is a *de facto* consortium-supported protocol specification initially developed by large computer graphics workstation suppliers. The X Consortium and the Open Software Foundation (OSF) have developed additional specifications like PEX (PHIGS Extensions to X) and OSF/Motif (a GUI) to support further device- and platform-indepen dence.

In the formal standards area, only Computer Graphics Interface (CGI, ISO 9636) is available. The CGI provides functionality similar to that of X, but it is not widely understood or accepted. ISO 9636 arrived too late to impact a market that had already committed itself to X. The CGI was developed by ISO/IEC JTC1/SC24 and is mainly compatible with the other standards developed by SC24. The CGI is available both as an API specification (in C and Ada) and as a data-stream definition.

7.4 SUMMARY

Software standards that support playback of multimedia titles overlap those that encourage program portability. The greater the degree of device-independence, programming-language independence, operating-system independence, and processor independence, the greater the portability. This widens the market for the playback application.

Hardware standards in this area deal either with device interfaces (e.g., MIDI) or with equipment configurations (e.g., Multimedia Personal Computer [MPC]). There are many other types of devices (tape recorders, cameras, etc.) that would benefit from standardizing their control and data interfaces. IMA's Multimedia System Services recommendations will influence functions provided in all playback devices.

8. MULTIMEDIA AND STORAGE

8.1 DEFINITION OF STORAGE

Standards for multimedia storage should support the long-term archival of collections of related multimedia data. They also should facilitate data access to allow data to be stored with related historical data, copyright information, etc.

8.2 STATE-OF-THE-ART

Multimedia storage is currently targeted at the data-unit level such as TIFF files, CGM files, and PostScript files. SGML and ODA documents can also be stored. However, where there are related entities, like a sequence of audio clips support ing an animation, there are few storage conventions. FLC/FLI from Autodesk and Macintosh's PIC are file formats supporting animation.

The DoD CALS initiative has specified a full archive file format known as MIL-STD-1840. The format details how technical documentation deliverables consist ing of text, CAD drawings, geometric graphics, and raster images can be stored in a single container.

The Open Media Framework (OMF) proposal for exchange-set descriptors layered upon the Apple Bento container file gives a comparable capability for compositions of time-based, synchronized multimedia presentations. This technical work has been submitted to the IMA for consideration for the exchange of multimedia data that require composition (as described in Chapter 3), but it has also been designed by the OMF partners to serve as an archival format.

The Office of Management and Budget (OMB) and the National Institute of Standards and Technology (NIST) have unveiled a new Federal Information Processing Standard 192 and an OMB Circular A-130 Bulletin 95-01 that establishes a standard federal format for electronic catalogs of government information. The Government Information Locator Service (GILS) took effect in June 1995 and will be a virtual catalog of information sources directly accessible via Internet. A GILS Application Profile on the American Standards Institute's Z39.50 standard for information search and retrieval complies with the Open Systems Interconnec tion model. The standard adopted for GILS makes minimal constraints on access.

8.3 SUMMARY

Aside from some specialized Government formats, there are no standards developed exclusively for long-term multimedia document storage and retrieval. Instead, multimedia information tends to be stored at the file-format level. Coordinating and controlling related pieces of information is generally left to the user, who has only simple file system mechanisms to rely on. The OMF proposal is the first of its kind coming from non-governmental sources. Its acceptability and future developments in this area will depend upon whether support for multimedia data bases is considered essential.

9. MULTIMEDIA AND DISTRIBUTED PROCESSING

9.1 STATEMENT OF THE PROBLEM

Significant technical, regulatory, and market issues confront integrated multime dia and distributed processing systems. Within these systems, advances in information processing and delivery of real-time, multimedia-based communica tions offer enhanced information transfer opportunities. Although the multimedia and distributed processing frameworks are well understood, competing trends need to be resolved.

Today, most information processing systems consist of heterogeneous collections of resources distributed across multiple locations. Even "stand-alone" systems typically interact with remote systems to access centralized services such as E-mail and databases. Heavy bandwidth dependencies and requirements for timely responsiveness using multimedia applications amplify the following issues that must be considered with distributed systems:

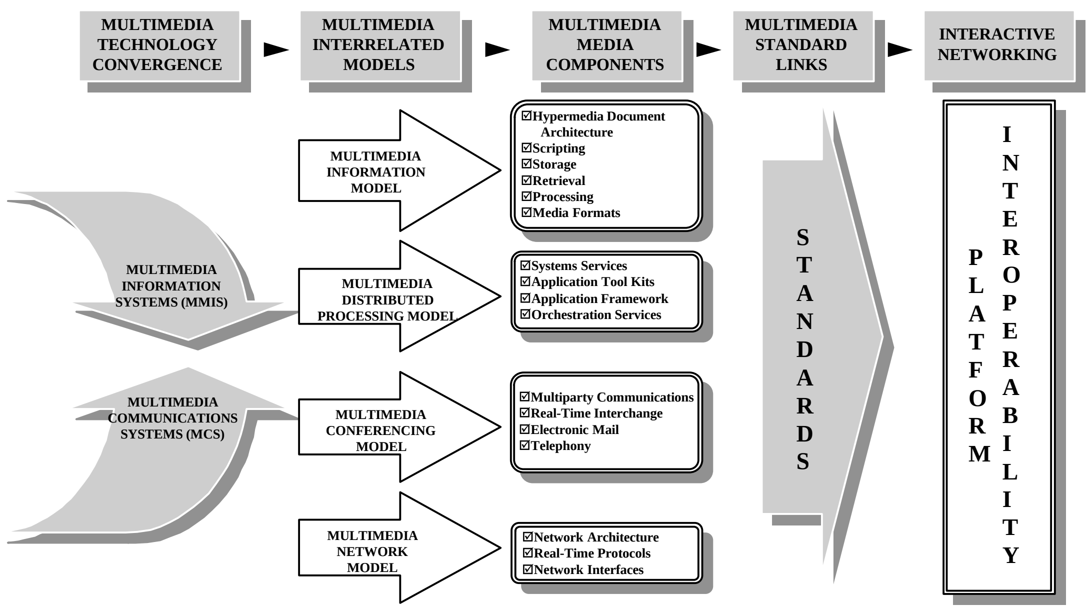
- Developing appropriate paradigms for distributed computation
- Establishing the infrastructure to support distribution of functionality
- Managing distributed systems
- Using remote resources
- Agreeing on standardized system components

Distributed computing appears deceptively simple: applications communicate among themselves by exchanging messages. Unfortunately, this is an oversimplification. Seeking common paradigms for both distributed and single-processor solutions, as well as paradigms that enable flexible distribution, add complexity.

The need to locate and use remote resources at run-time (instead of relying on a linkage editor when the application is built) also adds complexity. If distribution is to be supported in a heterogeneous, multivendor environment, there must be agreement on the systems' distributed components and interfaces (or protocols) to permit applications access. Managing distributed systems is more difficult than managing single-processor systems. Additionally, there are more failure modes (some temporary) and achieving agreement on the system state is complicated by time delays and potential communication failures.

9.2 STATE-OF-THE-ART

A layered view of a basic multimedia distributed processing model is shown in Figure III. Similar models have been published by the IMA in its Architecture



Model and Unix International's Open Distributed Multimedia Computing Model. Each layer provides services to the layer above. Significant additions to the facilities of traditional computing environ ments include (from the top):

Buford, John F. Koegel, "Multimedia Systems, " ACM Press, New York, N.Y., 1994. (Modified)

Figure III. Multimedia Distributed Processing Model:
A Layered View of a Distributed Environment

- **Scripting Languages.** Special-purpose programming languages for controlling multimedia documents, presentations, and applications

- **Media Device Control.** A combination of toolkit functions, programming abstractions, and services that provide application programs access to multimedia peripheral equipment

- **Interchange.** Multimedia data formats and services for interchanging multimedia content

- **Conferencing Services.** Facilities for managing multiparty communications using high-level call model abstractions

- **Hypermedia Engine.** A hypermedia object server that stores multimedia documents for editing and retrieval

- **Real-Time Scheduler.** Operating-system process or thread scheduling to meet real-time deadlines

Using basic system models, sophisticated user organizations with special needs have successfully developed and operated large-scale distributed systems for over 15 years, including those interchanging multiple data types. DoD and the intelligence community lead in this area, although their technology has been slow to find commercialization for two reasons:

- Economics today dictates a different mix of computing resources than in earlier systems. The model of interconnected large- and mid-scale computers with local terminals has been replaced. Now the model is one of interconnected, general-purpose workstations with mid-scale, specialized information servers.

- The advance of the computing industry has provided new technologies such as object-oriented systems and GUIs that must be successfully used in a distributed environment. This leads to attempts to "merge" new technologies with distributed processing techniques. An example is merging the X-Window System supporting a client-server distribution of a user interface and the IMA Draft Multimedia System Services Recommended Practice that plans to use object-oriented paradigms to access distributed services.

Examples of two popular standards used within the DoD and other intelligence communities are:

- The *National Imagery Transmission Format Standard (NITFS)*, Version 2.0, MIL-HDBK-1300, 18 June 1993, which describes the NITFS Format.

- The *Computer Graphics Metafile (CGM) Implementation Standard for the NITFS*, MIL-STD-2301, 18 June 1993, which describes the ISO CGM 89 Standard adopted for the description of graphical overlays within NITFS files.

Other NITFS standards are:

- MIL-STD-2500, *National Military Transmission Format, Version 2.0*
- MIL-STD 188-196, *Bi-Level Image Compression*
- MIL-STD-188-197, *Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) Compression Algorithm*
- MIL-STD-188-198, *Joint Photographic Experts Group (JPEG) Image Compression*
- MIL-STD-188-199, *Vector Quantization Decompression*
- MIL-STD-2045-44500, *Tactical Communications Protocol 2 (TACO2)*

The DISA/JIEO Circular 9008, 30 June 1993, *National Imagery Transmission Format Standards (NITFS), Test and Evaluation Program Plan* is also an excellent standards reference for NITFS projects.

Common paradigms for distributed computation include those resembling familiar single-processor paradigms (e.g., remote procedure call [RPC]), those that recognize and allow fine-grained management of remote resources (remote operations [RO]), and those that attempt to hide distribution altogether (object-oriented approaches). RPC and RO standards are part of the ITU-T X.400 series of recommendations that support remote interfaces to E-mail services (called Message Handling Systems in ITU-T jargon). Standardization of both RPC and RO is proceeding within ISO/IEC JTC1/SC21 as part of the common OSI application-layer services.

These lower-level paradigms can be used to define sets of standard interfaces to support distribution of specific system services. In a heterogeneous, multivendor environment, interface standardization is needed so system components may be purchased from separate vendors. Such standards lead to what is commonly called the *client-server* computing paradigm where applications can remotely access standardized system services. The SQL family of interfaces to database management systems is an example of a successful use of this paradigm. In addition, most vendors (such as Apple, DEC, Sun, and Microsoft) support some form of peer-to-peer computing, whereby one application can pass messages to another asking that some action be performed (such as initiate execution, print a file, or convert a file to another format). These peer-to-peer paradigms are in the early stage of commercial exploitation.

Significant system infrastructure is also needed to support distributed processing. The most important elements are the protocols and services being standardized by ISO/IEC JTC1/SC21 under OSI. Based on a common reference model, the Basic Reference Model of Open Systems Interconnection (ISO 7492), this set of stan dards will provide the ability to establish connections with varying properties among applications and perform common services such as file transfer. Although more technically advanced than competing *de facto* standards such as the DoD protocol suite, including FTP and TCP/IP, widespread availability of OSI services at reasonable cost has been hindered by two factors:

- Last generation protocol suites are included for "free" with many graphics workstations based on the Unix operating system.

- The growth and refinement of these obsolete suites of competing protocols has been publicly funded by the U.S. Government through many NASA and DoD programs. This has created further divergence in the marketplace: the illusion is created that it is not necessary to migrate to internationally standardized protocols to obtain needed functionality.

Another segment of infrastructure required to support distributed computing in a heterogeneous, multi-vendor environment is object systems. The industry consensus is that the best way to support distributed computing is by hiding the distributed nature with object-oriented paradigms. While there are many examples of successful single-processor systems developed with object-oriented techniques, there is still no agreement on the necessary services in a heterogeneous, multi-vendor environment. The work of ISO JTC1/SC21 in Open Distributed Processing (ODP) is still in its infancy and is only focusing on reference-model development at this time.

ODP is a new area of standards development. Begun in 1987, JTC1 has formed a new working group (SC21/WG7) to develop standards for an ODP Reference Model. ODP was also added to the SC21 title in 1993. The Reference Model for ODP (DIS 10746) provides the framework for standardizing ODP specifications, and enables a number of different approaches or solutions. The structure of the Basic Reference Model is as follows: WD 10746-1 (Part 1): *Overview and Guide to Use*, containing a motivational overview of ODP, giving the scope, explaining key definitions (with no substantial architectural content), and enumerating required areas of standardization (not normative). Committee Draft (CD) was scheduled for July 1994, DIS in January 1995, and IS in October 1996. Initiation of the ITU-TS ballot is expected in 1996. The most recent WD is SC21/WG7 N 885, November 1993. Other parts are: DIS 10746-2 (Part 2): *Descriptive Model*; DIS 10746-3 (Part 3): *Prescriptive Model*, and WD 10746-4 (Part 4): *Architectural Semantics*.

OMG is providing the first industry standards in the ODP area. OMG's Common Object Request Broker (CORBA) technology will provide a way to define and request services from (potentially distributed) objects. While the CORBA specification is being finalized, commercial implementations, especially interoperable specifications from different vendors, are not available.

Another emerging OMG recommendation is the Common Object Services Submission (COSS), also known as CORBAservices which provides common object naming, registration, and retrieval services. Serious compatibility problems remain in object-oriented programming languages (no C++ standard), in underlying support mechanisms (persistent storage for objects), and in object-oriented operating systems. Efficient support of object-oriented paradigms requires an underlying object-oriented operating system. The next generation operating system from most vendors (Microsoft, Apple, IBM, and Sun) will be object-oriented.

Although SC21 has developed a set of standards for managing communication resources, there are no standards for managing the general aspects of distributed systems. However, the IMA has developed a Draft Recommended Practice on Multimedia System Services (MSS) that includes basic concepts to manage multimedia resources in a distributed, heterogeneous, multivendor environment.

Using remote resources requires that applications have methods to agree on the names of resources, creating and registering resources (i.e., making them known to the system), locating resources by name rather than location (i.e., mapping names to addresses - a directory service), and agreeing on resource interfaces (the purpose of an interface repository). OSI services provide some assistance in this area (the X.500 Directory Services and OSI naming and addressing concepts), but general solutions that incorporate object paradigms needed for today's systems will likely come from industry consortia such as the OMG.

Distributed hypermedia systems are emerging from the research/development phase into the experimental deployment phase. However, existing global information systems, such as Gopher, Wide Area Information Server (WAIS), and World

Wide Web (WWW), are still limited to using external viewers for nontextual data. The most significant mismatches between the capabilities of currently deployed systems and user requirements are in areas of presentation and Quality Of Service (QOS), i.e., responsiveness.

Despite Gopher's wider deployment, WWW has high growth and appears to be the choice of future multimedia research and development. The reasons for this choice revolve around:

- Flexibility of the WWW design
- Availability of hyperlinks
- Existing effort already going into multimedia support in WWW
- Integrating a WWW solution incorporating both WAIS and Gopher support

Gopher is the main competitor to WWW, but its inflexible hierarchical structure and absence of hyperlinks make it difficult to use for highly-interactive multime dia applications.

9.3 SUMMARY

Standardized paradigms, protocols, and services to support distributed processing are still in early stages of development. Except in a few key areas such as database interfaces, vendors such as Microsoft, Apple, and DEC still perceive a substantial market advantage in retaining proprietary solutions. Building well managed distributed systems will continue to be difficult until the supporting infrastructure (OSI, ODP, or OS) is fully developed and widely implemented.

10. MULTIMEDIA AND COMPRESSION/CODING

10.1 STATEMENT OF THE PROBLEM

To accomplish successful interchange, information must be represented in a mutually agreed upon format. In addition, the agreed-upon format often compresses that information into fewer bits than required in the corresponding local format. For example, seconds of CD-quality digital audio data (44 Khz sample rate and 16 bits per sample) takes 1 MB of storage space, as does a single 640x480-pixel color raster picture with high-quality (24-bits per pixel) color. Compression is essential if audio, images, and video information are to be used economically in multimedia applications.

Because of bandwidth constraints, the principal focus of all coding work for audio and video information is concentrated on compression techniques. Compressing information to fit into the limited bandwidth available on current computer buses, local- and wide-area networks (LAN-WAN), and cable-television schemes is technically challenging and expensive. For example, film and video on television require playback frame rates of 24 or 30 frames per second respectively, with each frame containing a full monitor screen's worth of color information. For VHS video, this infers 32,768 colors. These 32,768 possible color points, at a screen resolution of 342x240 pixels, are repeated 30 times per second resulting in a storage requirement of 5 MB per second of video. A compact disc can only hold 136 seconds or 2.2 minutes of uncompressed VHS-quality video. Also, the speed (154 kilobytes [KB] of data per second) falls short of the 5 MB data stream needed for uncompressed VHS video.

Currently, the video data stream is restricted to 154 KB per second. However, hardware advances are increasing sustainable data rates, while data-compression techniques are reducing the amount of data required. Because of the high price attached to high data rates, compression systems offer an economical alternative and are favored as remedies to bandwidth restrictions. Thus, the principal focus of audio and video information coding work is on compression techniques.

10.2 STATE-OF-THE-ART

10.2.1 COMPRESSION

Tremendous progress has been made over the last several years in the develop ment of efficient and effective coding techniques for audio, images, and video information.

Compression of digital data involves developing algorithms that can be implemented on software, on hardware, or on a combination of the two. Often VHSI chips or programmable DSP chips are used for high-speed audio and video compression and decompression. (The term CODEC refers to dedicated chips that perform such COmpression and DECompression.) Different types of algorithms are used for compression. Some are based on signal processing algorithms, while others involve pattern recognition or extract statistical characteristics of a particu lar type of data.

Of interest to the information transfer community is hardware-assisted digital video. To decompress and display better quality digital video, computers use add-on hardware boards with dedicated and extremely fast video DSP chips. Two types of compression algorithm standards that require hardware-assisted decoding are:

- ***Interframe.*** (Production Level Video (PLV) and various MPEG algo rithms.) These use a combination of key motion-predicted and interpolated frames to achieve high compression ratios and low data rates. Years of committee work were completed in 1991, and MPEG-1 video was approved as an ISO Standard in late 1992. MPEG -1, like PLV, is designed to enable full-motion, full-frame, video playback from a CD-ROM at 1.2MB/s. MPEG-1 employs a Secure Input Format (SIF) for motion video and associated audio rates up to 1.5MB/s yielding picture quality comparable to or slightly better than VHS.

  MPEG-2 is being developed as a standard for high-quality delivery in broadcast and production applications. MPEG-2 will operate at full ITU-R 601 resolution (or greater) and at data rates from 2MB/s to 20MB/s. MPEG 2 is the data compression technique specified in HDTV by the Grand Alliance. ISO is expected to approve MPEG-2 by 1995.

- ***Intraframe.*** (TrueMotion and many forms of motion JPEG.) These systems individually compress every video frame (and sometimes every field). These algorithms provide quality video and offer the advantage of frame-accurate adaptability. The cost of the data rates, however, is 2 to 10 times higher than interframe algorithms. TrueMotion is an extension of compression algorithms available for the Intel i750 environment. A Pow er!Video compression station, with a data rate at the 640x480 pixel resolu tion of 4.8MB/s, will compress TrueMotion on a PC-class computer equipped with an

ActionMedia II capture and compression board. It can compress a minute of video in about 5 minutes.

Motion JPEG is a standard for still image compression that uses a DCT algorithm. Capture and compression systems can process video at 30 frames per second (fps) and recently as high as 60fps. Because of the high data rate and storage requirements, motion JPEG puts great demands on drives, buses, and processor, and is used infrequently for multimedia. However, it is widely used in closed-environment applications, such as video editing.

In addition to algorithm types, another compression issue is symmetry of the process. With symmetric algorithms, the compression process requires the same amount of clock time as the decompression (playback). On the other hand, the asymmetric compression process requires more clock time than decompression. Because most of the power is required for compression, asymmetric decompression can be done on low-cost computer equipment.

When considering compression schemes, it is important to consider compression ratio. Ampex and Sony use 2:1 ratios in the digital Betacam and DCT formats. At 2:1, the compression is virtually transparent. Many desktop system manufacturers indicate that ratios of 8:1 are barely noticeable. Compression schemes all look good at low ratios, but as these ratios are increased, the quality decreases. The reason is simple: reduced file size and limited system throughput. Both factors influence and affect the range used on various systems.

Lossless compression techniques allow the original data to be recovered in its exact form. ITU-T Group 3 and Group 4 fax compression are lossless techniques that combine Huffman and run-length encoding techniques. Lossy compression generally takes up less space when decoded into a form that humans find similar to the original. Predictive techniques, such as Adaptive Differential Pulse Coded Modulation (ADPCM), predict future values from past ones by transmitting only the (usually small) differences. ADPCM is successfully used for audio coding in many systems, such as the Sony-Phillips CD-I system and the CD-ROM-XA vendor standard. Motion compensation can exploit the fact that successive frames of video are often similar or differ only in the position of small blocks of pixels.

Joint Bi-level Imaging Group (JBIG) is a lossless compression algorithm for binary (one bit/pixel) images. JBIG models the redundancy in the image as the correlations of the pixel currently being coded with a set of nearby pixels called the template.

A specific suite of military standards known as NITFS is used to format digital imagery and imagery-related products for exchange within the intelligence community (reference Section 8, Multimedia and Storage). Two specific examples of NITFS compression/coding standards are:

- ***Adaptive Recursive Interpolated Differential Pulse Code Modulation (ARIDPCM) Compression Algorithm for the NITFS*** describes one of the compression options available for NITFS

- ***JPEG Image Compression for the NITFS*** describes an ISO standardized compression option available for NITFS

NITFS supports the wrapping of still imagery in a single file with associated data of any variety. This may include any combination of still visual data such as maps, imagery, or graphics. Photographic data are presented as a bit-map format. Associated nonphotographic data, such as overlays and maps, are given in the CGM format. The NITFS is also able to merge security-related information without destructive annotations to the imagery. Soon, all NITFS files will be converted to be included in HTML documents. NITFS files can be viewed using Mosaic, XV, or LView. The Central Imagery Office (CIO) anticipates that an NITFS viewer will be distributed in 1995. Each intelligence production center is currently redesigning its products to incorporate multimedia elements for on-line viewing. Table III illustrates key technologies of media type data compression.

Table III. Compression is a Key Enabling Technology for Multimedia Computing and Networking

Media Type	Lossy or Lossless	Standards	Compression Ratios
Audio	Lossy is acceptable	Standards set by the audio CD industry	4 to 1 achievable
Image	Lossy is acceptable Lossless	JPEG JBIG	25 to 1 with JPEG Varies with application
Text	Lossless	None	3 to 1 is achievable

Video	Lossy	MPEG	160 to 1 is achievable

Software Magazine, March 1994

10.2.2 CODING

Sub-band coding exploits characteristics of human perception by noting individuals have different sensitivities to different spatial and temporal frequency ranges. This allows more bits to be allocated to the information that humans notice the most. Transform coding is used to change spatial or temporal information into frequency data so that less important information can be discarded. For example, using the Discrete Cosine Transform (DCT) in image compression techniques, such as JPEG, enables low-frequency data to be coded more carefully than high- frequency data.

In coding, more bits might be used to code low-frequency parts of images in more noticeable areas. Also, more bits could be used for luminance than for chrominance as the human eye is more sensitive to lower frequencies and can distinguish more luminance levels.

Most modern techniques, such as JPEG, H.261, and MHEG are hybrid lossy techniques that combine transform coding with other methods. JPEG provides different options for different situations, but processing typically involves a forward DCT with scaler quantization followed by either a Huffman or an arith metic coding step. ITU-T Recommendation H.261 is often referred to as "px64" since it involves options for producing compressed video streams at multiples of 64 kilobits per second (Kbps) from 1 to 30 (the "p" value). At p = 1 or 2, videophone applications are possible, while video-conferencing is possible at p > 5. ITU-T H.261 coding uses DCTs on 8x8 blocks, followed by differential PCM with motion estima tion. MPEG encompasses both audio and video compression. MPEG video reduces 360x240 VHS-quality video into a 1.2 Mbps stream using techniques similar to H.261. MPEG audio supports CD quality audio at a bit rate of 128 Kbps or 64 Kbps. The MPEG "system" is designed to encode a television-quality signal in a T1 (1.544 Mbps) data stream.

In addition to these international standard compression techniques, a variety of proprietary coding techniques are defined by vendors or groups of vendors. Platform vendors, such as NeXT and Apple, have developed their own proprietary multimedia formats (see Chapter 3). These are not necessarily restricted to a single platform, as Apple has also developed products supporting its QuickTime format on

IBM-PC platforms. The CD-I format developed by Phillips was the first multimedia format targeted at the price-sensitive consumer market. While CD-I was finalized in 1987, the first products did not reach the market until 1991. The CD-ROM-XA format includes specifications for interleaved audio and video data streams, and Intel's DVI is a continually evolving architecture centered on using their Pentium processing chip set.

10.3 SUMMARY

As analog technology gives way to digital technology, data rates are increasing rapidly. For uncompressed 24-bit video, typical data rates are 200Mbps. Unfortunately, many desktop systems can only sustain data rates in the 2Mbps to 5MB/s range. A wide variety of different audio, video, and still-image compression techniques are now available for multimedia data types. The best techniques are hybrid and are carefully tuned to data characteristics and available bandwidth of the target transport mechanism. Given this variety, there is little justification for the continued use of proprietary techniques in open interchange.

With both hardware-assisted and software-only playback of digital video, users have a broad range of compression algorithms to choose for their application. Although much is written about a standard in the digital video market, users today tend to choose an algorithm that closely satisfies various factors of data rate, quality, and playback costs. However, video compression remains the paramount selection issue. Users can look forward to progress as model-based, fractal, and other emerging compression techniques become commercially feasible and standardized.

APPENDIX A

STATUS OF FORMAL AND *DE FACTO* STANDARDS

APPENDIX A		PAGE

APPENDIX A.1

GRAPHICS, RASTER

A.1 GRAPHICS, RASTER

IMPACT OF STANDARDS ON THE USE OF RASTER GRAPHICS

When creating a document or an on-line file, it is important to know the type of graphic image you are using. For example, in WordPerfect for Windows, it is possible to invert, outline, convert to black and white, or rotate in 90-degree increments any bit-mapped image placed in a graphics box. It is necessary to know if the image you are importing is a raster graphic because a vector graphic can be placed in the box, but cannot be modified. If modifying the image is important, a vector graphic cannot be used in that box.

In another WordPerfect example, when using the rotate command, a bit-mapped graphic can only be rotated by 90-degree increments; a vector graphic could be rotated from 1 to 360 degrees. Again, it is necessary to know the format (stan dard) of the graphic you wish to use to know how much it can be modified.

One design economy is to reuse a graphic in different applications. To do this, each application must be able to read the format (standard) in which the graphic was created. If graphics are based on a proprietary standard, other applications will be unable to use (read) them. Additionally, if a graphic is imported (trans ferred) into another application, it may be impossible to edit. Transfer and modification capabilities are dependent on standards.

The recommended practice is to choose a raster-format graphic if the image has extensive gradation such as a photo or snapshot, if clean-up work needs to be done on the image, or if touch-ups or minor modifications are needed and pixel-by-pixel control is required. For example, an article on ancient Egypt may have a photo of a pyramid, but there is a definite twentieth-century artifact in the image. Pixel control will enable elimination of the anachro nism in the photo and back fill the area to match the surroundings.

The remainder of this section catalogs common Raster Graphic standards in use today. One of the most commonly used *de facto* industry standards, GIF, recently became proprietary when Unisys, the holder of the copyright on the LZW compression scheme underlying GIF began requiring licensing for all software developers using GIF. In response, CompuServe, the publisher of GIF, has issued PNG to replace GIF as an industry *de facto* standard. While PNG is expected to meet future requirements for graphics interchange on the Internet, on CompuServe, and on other services as well as for the exchange of information between graphics software products, it is not backward compatible with the current GIF specifica tion.

GIF

Standard:	Graphics Interchange Format Version 89a
Designation:	GIF89a
Status:	Industry, Proprietary
Publisher:	CompuServe
Date of Publication:	1990
Description:	The Graphics Interchange Format defines a protocol intended for the on-line transmission and interchange of raster graphic data in a way that is independent of the hardware used in their creation or display. GIF provides the following capabilities and restrictions: - LZW compression, - single image per file, - 8-bit color depth (color table). LZW compression has been patented by Unisys since 1985. In 1995, Unisys began requiring licensing for all software developers using, GIF, previously in the public domain. GIF is defined in terms of blocks and subblocks that contain relevant parameters and data used to reproduce a graphic. A GIF data stream is a sequence of protocol blocks and sub-blocks representing a collection of graphics. In general, the graphics in a data stream are assumed to be related to some degree, and to share some control information.

A data stream may originate locally, as when read from a file, or it may originate remotely, as when transmitted over a data communications line. The Format is defined with the assumption that an error-free Transport Level Protocol is used for communications; the Format makes no provisions for error-detection and error-correction.

The GIF format uses color tables to render raster-based graphics. The concept of both global and local color tables is supported to enable the optimization of data streams. The decoder of an image may use a color table with as many colors as its hardware is able to support. If an image contains more colors than the hardware can support, algorithms not defined in the "standard" must be employed to render the image. The maximum number of colors supported by the "standard" is 256.

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IPI-IIF

Standard: IPI (Image Processing and Interchange) - IIF (Image Interchange Format)

Designation: ISO/IEC 12087-3

Status: IS, Formal

Publisher: ISO/IEC

Date of Publication: 1994

Description: The Image Interchange Facility (IIF) is part of the first International Image Processing and Interchange Standard (IPI), which is under elaboration by ISO/IEC JTC1/SC24. IIF comprises both a data format definition and a gateway functional specification.

Part 1 provides a platform-independent architecture and a set of common image-related data types, operations, etc. Part 2 provides an API for a useful set of image processing primitives, thereby promoting program portability. Part 3 (the IIF) provides an image interchange format, richer than either CGM or any *de facto* standard format (like TIFF) and promotes transparent data exchange.

The main component of the IIF is the definition of a data format for exchanging arbitrarily structured image data. The IIF defines a format that can be used across application boundaries and that can easily be integrated into international communication services. Besides the definition of a file format, there are definitions of parsers, generators, and format converters to enhance open image communications.

The IIF approach clearly distinguishes between the image structure (a data type-oriented description of the image), image attributes (expressing colorimetric and geometric semantics), the sequential data organization (managing data partitioning and periodicity organization), and the data encoding/compression. The syntax specification and the data encoding of syntax entities use ASN.1 (Abstract Syntax Notation) and the Basic Encoding Rules, respectively. For the compressed representation, the following standards are referenced: JBIG, facsimile Group 3 and 4, JPEG, and MPEG.

Besides the data format specification, the IIF also encompasses functionality for generating and parsing image data, for compressing and decompressing, and for exchanging image data between the application program, the Programmer's Imaging Kernel System (PIKS) (which is Part 2 of the IPI standard), and storage/communication devices. This functionality is located in the so-called IIF Gateway. The IIF gateway controls image data being imported and exported to and from applications, as well as to and from the PIKS.

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ITU-T T.6

Standard:	Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus - Terminal Equipment and Protocols for Telematic Services (Study Group VIII) Group 4 fax
Designation:	T.6
Status:	ITU Recommendation, Formal
Publisher:	ITU
Date of Publication:	February 1990
Description:	A widely used compression technique for bi-tonal raster data. A combination of different techniques can be used, including 2D READ coding, 1D modified Huffman coding, and uncompressed mode (bitmap). The data themselves do not carry information about the number of pixels per line or the total number of lines in the image, so this information must be exchanged in a header (when used in computer networks) or an enveloping protocol such as T.30, when used in the Public Switched Network (PSN) for fax transmissions.
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JBIG

Standard:	JBIG (Joint Bi-Level Imaging Group)
Designation:	ISO/IEC 11544; ITU-T Recommendation T.82
Status:	IS, Formal; ITU-T Recommendation
Publisher:	ISO; ITU
Date of Publication:	1993
Description:	JBIG is a lossless compression algorithm for binary (one bit/pixel) images. It models the redundancy in the image as the correlations of the pixel currently being coded with a set of nearby pixels called the template. A template example might be the two pixels preceding this one on the same line, and the five pixels centered above this pixel on the previous line. Note that this choice only involves pixels already seen from a scanner. The current pixel is then arithmetically coded based on the 8-bit (including the pixel being coded) state so formed. So there are (in this case) 256 contexts to be coded. The arithmetic coder and probability estimator for the contexts are actually IBM's (patented) Q-coder. The Q-coder uses low-precision, rapidly adaptable (those two are related) probability estimation combined with a multiply-less arithmetic coder. The probability estimation is intimately tied to the interval calculations necessary for the arithmetic coding. JBIG actually goes beyond this and has adaptive templates.

JBIG can be used on gray scale, or even color images, by simply applying the algorithm one bit-plane at a time. You would want to recode the gray or color levels first though, so that adjacent levels differ in only one bit (called Gray-coding). This works well up to about 6 bits per pixel, beyond which JPEG's lossless mode works better. The Q-coder must be used with JPEG to get this performance.

Since it is lossless, JBIG can be used for storing document images and they'll be legally admissable as exact replicas of the originals. Moreover, JBIG improves compression ratios by 40% (on simple documents) to 180% (on complex images) over ITU-T Group IV, but takes two to five times as long to compress and decompress in software.

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JPEG

Standard:	JPEG (Joint Photographic Experts Group), Coding of Digital Continuous-Tone Still Pictures, Part 1: Requirements and Guidelines; Part 2: Compliance Testing, Part 3: Extensions
Designation:	ISO/IEC 10918 Parts 1-3; ITU-T Recommendation T.81 (Part 1); ITU-T Recommendation T.83 (Part 2)
Status:	IS, Formal; DIS status expected in early 1996 for Part 3; ITU-T Recommendation
Publisher:	ISO; ITU-T
Date of Publication:	February 1994 (Part 1); June 1995 (Part 2); DIS expected early 1996 (Part 3)
Description:	JPEG is a standardized image compression mechanism. JPEG stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard. JPEG is designed for compressing either full-color (24 bit) or gray-scale digital images of "natural" (real-world) scenes. JPEG does not handle black-and-white (one bit/pixel) images, nor does it handle motion picture compression. JPEG is "lossy," meaning that the image you get out of decompression isn't identical to what you put in. The algorithm achieves much of its compression by exploiting known limitations of the human eye, notably the fact that small color details aren't perceived as well as small details of light and dark. Thus, JPEG is intended for compressing images that will be looked at by humans. If you plan to machine-analyze your images, the small errors introduced by JPEG may well be a

problem for you, even if they are invisible to the eye.

A useful property of JPEG is that the degree of lossiness can be varied by adjusting compression parameters. This means that the image maker can trade off file size against output image quality. You can make extremely small files if you don't mind poor quality; this is useful for indexing image archives, making thumbnail views or icons, etc. Conversely, if you aren't happy with the output quality at the default compression setting, you can jack up the quality until you are satisfied and accept lesser compression.

Although it handles color files well, it is limited in handling black-and-white and files with sharp edges (files come out very large). The processing costs, even on up-to-date computers, is also high.

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MIL-PRF-28002B

Standard:	Requirements for Raster Graphics Representation in Binary Format (Group 4 Raster Scanned Images)
Designation:	MIL-R-28002B
Status:	Military standard
Publisher:	DoD
Date of Publication:	18 November 1992
Description:	This is the scanning standard for exchange of data in raster file format. It specifies two types of raster graphics data: Type I, Untiled Raster Graphics Data and Type II, Tiled/Untiled Raster Graphics Data.
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E-mail address:	
WWW URL:	**http://wpaftb1.wpafb.af.mil/**

NITFS

Standard:	NITFS (National Imagery Transmission Format Standard), Version 2.0
Designation:	NITFS
Status:	Government
Publisher:	DoD
Date of Publication:	June 1993
Description:	The NITFS defines the standard for formatting digital imagery and imagery-related products and exchanging them between members of the Intelligence Community and other departments or agencies of the United States Government. This standard consists of a format and its image and communications processing components. The full standard includes the interchange of images (based on JPEG), symbols (including graphics based on CGM), labels, and text.
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WWW URL:	**http://www.itsi.disa.mil/ismc/**

PCX

Standard:	PC Paintbrush Format
Designation:	PCX
Status:	Vendor, Informal
Publisher:	Softkey Corporation
Date of Publication:	
Description:	PCX is one of the oldest and most common raster formats available on PCs. It is simple to read and write, and most graphics and desktop publishing programs that import raster graphics support the PCX format (almost all draw and paint programs). Although it usually supports up to 256 colors, it does provide for custom palettes. Extensions to PCX have been made for full color operation.
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WWW URL:	**http://www.softkey.com**

PNG

Standard: PNG-based Graphics Specification

Designation: PNG

Status: Industry, de facto

Publisher: CompuServe

Date of Publication: June 1995

Description: PNG is a fully open 24-bit lossless graphics specification for electronic graphics exchange. It is a significant enhancement to the earlier GIF 89a specification, while also eliminating the proprietary LZW software, replacing it with compression technology compliant with the PNG specification. The specification was developed as a collaborative effort between CompuServe and the Internet PNG Group.

CompuServe believes that the new specification closely meets the future requirements for graphics interchange on the Internet, on CompuServe, and on other services, as well as for exchange of information between graphics software products. PNG makes use of a data compression technology called "deflation" used in the freeware Info-Zip programs.

CompuServe is creating a free toolkit to which it will hold a copyright, however it is understood that its free distribution and use is encouraged and expected. To maintain the free and clear patent status of the new specification, it will not be backward compatible with the current GIF 89a specification.

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TIFF

Standard:	TIFF (Tagged Image File Format)
Designation:	TIFF 6.0
Status:	Vendor; de facto
Publisher:	Microsoft/Aldus/HP
Date of Publication:	1986
Description:	TIFF is used for desktop publishing, fax, and scanner data exchange. It defines a complete format for general raster interchange, creating bitmap files. It is one of the most flexible and complicated formats. There are many versions, and no application supports all versions. In the design of the TIFF format, a great deal of effort was taken to provide for extensibility while maintaining backward compatibility. The only demand that TIFF places on the individual operating system is that the associated storage medium supports a file structure making it almost operating-system independent. In addition, the overhead of the format is quite low for the level of sophistication it possesses, making it fast and efficient to access. For these reasons, TIFF has become a popular format among distributors of digital images and peripheral manufacturers. Another useful feature of the format is the availability of special-purpose user-defined tags for including application defined data. The producer of an image may include information such as source or special viewing parameters directly in the image header where they will not become separated from the image itself.

With the introduction of TIFF version 6.0, direct JPEG compression was introduced. In this version, several newly defined fields provide information required by JPEG software to decompress an image such as the type of JPEG algorithm used and byte offsets to the required quantization tables.

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APPENDIX A.2

GRAPHICS, VECTOR

A.2 GRAPHICS, VECTOR

IMPACT OF STANDARDS ON THE USE OF VECTOR GRAPHICS

When creating a document or an on-line file, it is important to know the type of graphic image you are using.

Vector graphics have a reduced file size compared to bit-mapped graphics. Vector graphics contain intelligence. Some of the image data are interpolated rather than read bit by bit, so the files are smaller than bit-mapped graphics and processing time is faster.

The embedded data in vector graphics affect how the graphics can be displayed. For example, it makes 3D images possible, shortens the time needed to process the image, and reduces the file size required to display the image. If processing time and file storage size are critical, work with vector rather than raster graphics.

Vector graphics are objects. The objects can be placed on top of one anoth er, but the underlying object is not affected, just merely concealed or overlayed. Unlike a bit-mapped graphic, it is impossible to cut out part of one of the images, only obscure it under something else. For example, if a script directed illustration of the concept of "two" and had an image of three cars, it would be impossible to eliminate one car. However, it would be possible to conceal it behind another object, such as a garage, by placing that image (object) to overlay part of the car image.

Another characteristic of vector graphics is that each dimension of a 3D object has properties. A line is not a series of pixels, but the connection between two coordinates. The vector line has an exact length as well as other properties. A cube has x,y,z dimensionality with properties as a whole and properties on each side. This allows programs such as stress analysis, heat transfer analysis, and other engineering tests to be performed on the image. Such programs cannot be applied to a two-dimensional image.

How the image is to be used determines what standard you should choose. For example, DXF is AutoCAD specific. PHIGS is the model for 3D geomet ric graphics, as is GKS, which is similar but a simpler, less powerful model for 2D and 3D picture display and interaction. IGES is for the exchange of 3D data in vector file format, particularly for documents prepared in Computer-

Aided Design/Computer Aided Manufacturing (CAD/CAM). PHOTO CD defines standards for storage and retrieval of photographic images on compact disk. It is important to select the right level of perfor mance for the application.

DXF

Standard:	Document Interchange Format
Designation:	DXF
Status:	Vendor, Informal
Publisher:	Autodesk
Date of Publication:	Unknown
Description:	Autodesk's format for moving AutoCAD drawings to and from the rest of the world.
Editor/Point-of-Contact:	Autodesk, Inc.
Address:	2220 Marinship Way Sausalito, CA 94985
Telephone/Fax:	415-332-2344 415-507-5100 (fax)
E-mail address:	
WWW URL:	**http://www.autodesk.com**

GKS

Standard:	GKS (Graphical Kernel System)
Designation:	ANSI X3.124; ISO 7942; FIPS 120
Status:	IS; ANSI; FIPS; Formal
Publisher:	ISO
Date of Publication:	Revised 1994
Description:	GKS/GKS-3D is a machine- and language-operating system and device-independent specification of a set of services for displaying and interacting with 2D and 3D pictures. GKS language bindings (ISO 8651 and ISO 8806) for C, Fortran, and Ada provide the language-specific instantiation of the GKS functionality for application programmers seeking cross-platform portability. GKS is simpler, but less powerful than PHIGS.
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IGES

Standard: Digital Representation for Communication of Product Definition Data: IGES (Initial Graphics Exchange Specification) Application Subsets and IGES Application Protocols

Designation: ANSI/US PRO/IPO-100-1993 (formerly ASME/ANSI Y14.26M - 1989); MIL-D-28000A; FIPS 177:1992

Status: ANSI standard (1993); MIL-D (1992); FIPS

Publisher: ANSI; DoD; Federal Government

Date of Publication: 1993

Description: IGES Version 5.0, is an ANSI standard developed by the American Society for Mechanical Engineers (ASME) for the exchange of 3D data in vector file format, particularly for documents prepared in Computer-Aided Design/Computer Aided Manufacturing (CAD/CAM). It is based on the work of the IGES/PDES Organization, which is chaired by NIST. This group establishes information structures to be used for the (1) digital representation and communication of product definition data and (2) representation and transfer of vector graphics data used by various CAD/CAM systems.

MIL-D-28000A, *Digital Representation for Communication of Product Data:* IGES *Application Subsets*, February 1992, identifies the requirements to be met when product definition data are delivered in the digital format of IGES as specified by ANSI standard Y14.26M. MIL-D-28000A is designed to be incorporated into a contract to define the technical requirements to be met when pur-

	chasing product definition data or product data in digital form.
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PHIGS

Standard:	PHIGS (Programmers' Hierarchical Interactive Graphics System)
Designation:	ISO/IEC 9592:1989; ANSI X3.144-1988
Status:	IS; ANSI; Formal
Publisher:	ISO
Date of Publication:	1988; 1989
Description:	PHIGS is a machine- and language-independent operating system and device-independent specification of a set of services for displaying, manipulating, and interacting with a 3D geometric graphics model. PHIGS language bindings (ISO/IEC 9593) for C, Fortran, and Ada provide the language-specific instantiation of the PHIGS functionality for application programmers seeking cross-platform portability. Part 1 deals with the PHIGS Functional Specification. Parts 2 and 3 of PHIGS specify the semantics and syntax of an "archive file" capable of being used to interchange PHIGS geometry models. PHIGS Archive Files and Archive File Clear Text Encoding, respectively. Part 4 is the PHIGS PLUS Functional Specification.
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PHOTO CD

Standard Designation:	PHOTO CD
Status:	Vendor, Informal
Publisher:	Eastman Kodak
Date of Publication:	September 1990
Description:	Based on Orange Book standards, Photo CD uses the ISO 9660 and 9660+ (the current appendable version of 9660). It has a block structure and supports block, track, and index table addressing.
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STEP

Standard:	Industrial automation systems and integration, Product Data Representation and Exchange - Part 1: Overview and Fundamental Principles; Part 11: Description methods: The EXPRESS language reference manual; Part 21: Implementation methods: Clear text encoding of the exchange structure; Part 31: Conformance testing methodology and framework: General concepts; Part 32: Conformance testing methodology and framework: Requirements on testing laboratories and clients; Part 41: Integrated generic resources: Fundamentals of product description and support; Part 42: Integrated generic resources: Geometric and topological representation; Part 43: Integrated generic resources: Representation structures; Part 44: Integrated generic resources: Product structure configuration; Part 46: Integrated generic resources: Visual presentation; Part 101: Integrated application resources: Draughting; Part 201: Application protocol: Explicit draughting; Part 203: Application protocol: Configuration controlled design
Designation:	ISO/IEC 10303:1994; STEP
Status:	IS
Publisher:	ISO/IEC
Date of Publication:	1994
Description:	This standard provides a representation of product information along with the necessary mechanisms and definitions to enable product data to be exchanged. The exchange is among different computer systems and environments associated with the complete product lifecycle in-

cluding product design, manufacture, use, maintenance, and final disposition of the product. Many other parts (at least 213) are still under development.

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X WINDOWS BITMAP

Standard:	X-Windows Portable Bitmap Format
Designation:	
Status:	Industry, Informal
Publisher:	X Consortium
Date of Publication:	
Description:	The X-Windows bitmap format is a simple stream of characters representing a 2D pixel map. No compression is supported. An optional "hot spot" (the coordinates of a point of alignment, for example) may be stored along with the bitmap.
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APPENDIX A.3

GRAPHICS, METAFILES

A.3 GRAPHICS, METAFILES

IMPACT OF STANDARDS ON THE USE OF GRAPHIC METAFILE FORMATS

To allow image transfers among different systems, a wide range of parameters must be agreed upon. These include raster formats; frame rates for capture, transmission and display; new scanning methodologies; and issues relating to color representation and to color processing.

The American College of Radiologists/National Electrical Manufacturers Association (ACR/NEMA) Digital Imaging Communications (DICOM) standard (formerly Medical Informatics Standard) was created to provide a standard way of shipping medical images among different manufacturers' equipment. A variety of images are included: ultrasound, magnetic resonance imaging (MRI), computer tomography (CT), etc., in sequences of two. The standard specifies everything from the connec tor and the communications protocol to use of the image data-field contents. It was updated in 1992-1992, renamed DICOM, and reissued in 9 parts.

The Computer Graphics Metafile (CGM) format is an independent interchange format that is a national standard. CGM supports geometric shapes, raster graphics, and several color models. Image appearance can be affected by attributes such as fill pattern and line join. This standard is computer- and operating-system independent.

Macintosh has a proprietary metafile format (PICT), as do OS/2 Presenta tion Manager (MET), Postscript (EPS), and Windows/OS2 (BMP). The BMP metafile stores device-independent bitmaps and has a built-in compression method at 4 bpp or 8 bpp, but is uncompressed at 24 bpp. The device reading the files must be able to support the standard under which they were stored.

CGM

Standard:	CGM (Computer Graphics Metafile)
Designation:	ISO/IEC 8632:1992
Status:	IS; Formal
Publisher:	ISO/IEC
Date of Publication:	1992
Description:	The CGM is a computer- and operating-system independent interchange format. There are elements to represent both geometric graphics content (e.g., circles, polygons) and raster graphics (e.g., pixel arrays). An element's appearance can be affected by attributes (e.g., line cap, line join, mitre limit, fill pattern). Several color models (RGB, CMYK, etc.) are supported. CGM is widely used in the publishing industry. The elements contained in a CGM file represent a wide range of pictures types. The elements are split into functional groups that delimit major structures: (1) define the representations used within the metafile; (2) control the display of the picture; (3) perform basic drawing functions; (4) control the attributes of the basic drawing actions; and (5) provide access to non-standard devices. The file structure is defined to allow sequential access and random access to individual picture elements. Elements can also be grouped into logical or functional segments, allowing all picture elements of a certain type (all shoreline elements for instance) to be grouped together.

A functional specification and three standard encodings of the metafile syntax are specified. These encodings address the needs of applications that require minimum metafile size, minimum effort to generate and interpret, and the needs of maximum flexibility for a human reader or editor of a metafile.

Every CGM file contains a set of descriptor elements (a descriptive header) that defines versions, colors, fonts, and metafile precision. A list of the standard elements such as fill pattern tables and line styles that occur in the metafile is also present in this header. With this information, software is able to gauge the functional capabilities required to successfully interpret a CGM file and exit gracefully if these capabilities are not available.

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CGM (FIPS)

Standard:	CGM (Computer Graphics Metafile)
Designation:	FIPS 128-1 (supercedes FIPS 128-1987)
Status:	FIPS; Government
Publisher:	NIST
Date of Publication:	1993 (FIPS 128-2 undergoing comment/public review. Expected late 1995)
Description:	FIPS 128-1 is currently being revised to adopt ANSI/ISO 8632.1-4:1992 [1994] and CGM Amendment 1: Rules for Profiles, ISO/IEC 8632:1992/Amd.1 ('1994' is when ANSI actually adopted 8632). Use of profiles will also be required. Several profiles will be adopted, one of which is required for implementation of this FIPS. The profiles are: Model Profile (as specified in Amd.1), ATA profile, and MIL-D-28003A.
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DICOM

Standard:	Digital Imaging Communications (formerly, ACR/NEMA) PS 3.1-1992, Introduction and Overview PS 3.2-1993, Conformance PS 3.3-1993, Information Object Definitions PS 3.4-1993, Service Class Specifications PS 3.5-1993, Data Structures and Encoding PS 3.6-1993, Data Dictionary PS 3.7-1993, Message Exchange PS 3.8-1992, Network Communication Support for Message Exchange PS 3.9-1993, Point-to-Point Communication Support for Message Exchange
Designation:	DICOM 3.0 (formerly ACR/NEMA Standards Publication No. 300)
Status:	Formal
Publisher:	Developed jointly by the American College of Radiologists (ACR) and the National Electrical Manufacturers Association (NEMA)
Date of Publication:	1992-1993
Description:	The DICOM standards were created to provide a standard way of shipping medical images among different manufacturer's equipment. They cover Computer Tomography (CT), MR, ultrasound, PET images, etc. and currently supports sequences of 2. The standards specify everything from the connector to be used, to the communications protocol, to the contents of data fields in the images.
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WWW URL: **http://www.xray.hmc.psu.edu/dicom/dicom_home.html**

PICT

Standard:	Apple MacPaint format
Designation:	PICT
Status:	Vendor, Informal
Publisher:	Apple Computer
Date of Publication:	
Description:	Apple MacPaint is an older raster metafile format for Macintosh applications. Only fixed size (576x720) monochrome images are supported. Simple run-length compression is used. Apple MacPaint is used to interchange graphics data among nearly all Macintosh applications. It is not widely used on PCs, but some file conversion programs do support importing it (such as .PCT files).
Editor/Point-of-Contact:	Rita Brennan
Address:	Apple Computer, Inc. 20525 Mariani Avenue Cupertino, CA 95014
Telephone/Fax:	408-996-1010 408-974-0866 (fax)
E-mail address:	
WWW URL:	**http://www.apple.com**

Some additional industry graphic formats include:

BMP. This format is used for both Project Management (PM) and Windows bitmaps. However, the format is different between Windows and OS/2. BMP stores a device-independent bitmap. It has a built-in compression method for either 4 bpp or 8 bpp. It supports up to 24 bpp, but uncompressed.

EPS. This is the Encapsulated PostScript format, developed for use with PostScript printers. It is a metafile format and is flexible; it is supported by many drawing programs.

HPGL. This is the Hewlett Packard (HP) Graphic Language vector format. It was originally developed to send commands to a line-drawing plotter.

MET. This is the PM metafile format. It is specific to OS/2 Presentation Manager, and supports both bitmaps and vector data.

TGA. This is the TARGA image format, first used with the True-vision TARGA real-video boards. It supports up to 32 bits per pixel and is widely used to distribute photo-realistic images. TGA stores RGB information directly and therefore does not require color palettes.

APPENDIX A.4

VIDEO, ANALOG

A.4 VIDEO, ANALOG

IMPACT OF STANDARDS ON USE OF ANALOG VIDEO

Analog video is hardware dependent and has several transmission stan dards: Phase Alternating Line (PAL), Sequential Couleur avec Memoire (SECAM), National Television Standards Committee (NTSC), and the emerging high-definition TV (HDTV) standards.

ATSC, the Advanced Television Systems Communications was formed by the Joint Committee on Inter-Society Coordination (JCIC) to establish voluntary technical standards for advanced television systems, including HDTV. In April 1995, the ATSC approved the Digital Television Standard for HDTV Transmission (ATSC A/53).

PAL is not a single format; variations are used in Australia/New Zealand, China, Brazil, and Argentina.

The user must know in which format the video was recorded (and, in the case of PAL, which version of PAL). Only hardware meeting the specifica tions of the correct standard will be able to play back the video.

Beneficially, analog video has been around for some time. Existing standards are well defined and stable. It is the format of choice for the entertainment industry due to the widespread base of hardware at the consumer level.

Analog video is also the format of choice for the television industry. The emerging market in high-definition television is analog based. The HDTV standards are extensions of the analog video work that had already been done.

Much live teleconference and teleclass material is transmitted from the camera over a satellite or land line as an analog signal. The voice circuits for these uses are also often analog signals.

Although analog video is being used less and less with digital multimedia (eliminating the need for an external hardware feed), there is still a wide market for analog video materials.

<u>**ATSC A/52**</u>

Standard:	Digital Audio Compression (AC-3) Standard
Designation:	ATSC A/52
Status:	Industry standard; Formal
Publisher:	ATSC
Date of Publication:	1995
Description:	This standard specifies the AC-3 systems proposed by Dolby Laboratories. Annex A describes the use of AC-3 in an MPEG-2 multiplex.
Editor/Point-of-Contact:	
Address:	Advanced Television Systems Committee (ATSC) 1750 K Street N.W. Suite 800 Washington, DC 20006
Telephone/Fax:	202-828-3130 202-828-3131 (fax)
E-mail address:	
WWW URL:	**http://www.atsc.org/**

ATSC A/53

Standard:	Digital Television Standard for HDTV Transmission
Designation:	ATSC A/53
Status:	Industry Standard; Formal
Publisher:	ATSC
Date of Publication:	1995
Description:	The U.S. ATSC has documented the digital television standard for HDTV transmission proposed by the Grand Alliance and approved by the Technical Subgroup of the Federal Communications Commission (FCC) Advisory Committee. Equipment built to this standard is now undergoing laboratory testing. The standard specifies the HDTV video formats, the audio format, data packetization, and RF transmission. New television receivers will be capable of providing high resolution video, CD quality multi-channel sound, and ancillary data delivery to the home. It is anticipated that this standard will be recommended to the FCC later in 1995 as the basis for a new generation of television distribution for the U.S. ATSC is now focused on a further refinement of the standard that will permit the delivery of "digital standard definition television."
Editor/Point-of-Contact:	
Address:	Advanced Television Systems Committee (ATSC) 1750 K Street N.W. Suite 800 Washington, DC 20006
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WWW URL:	**http://www.atsc.org/**

ATSC A/54

Standard:	Guide to the Use of the Digital Television Standard for HDTV Transmission
Designation:	ATSC A/54
Status:	Industry standard; Formal
Publisher:	ATSC
Date of Publication:	1995
Description:	This document was written as a tutorial for non-expert technical person.
Editor/Point-of-Contact:	
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Telephone/Fax:	202-828-3130 202-828-3131 (fax)
E-mail address:	
WWW URL:	**http://www.atsc.org/**

EBU TECH. 3271

Standard:	Interlaced version of the 1250/50 HDTV production standard
Designation:	EBU Tech. 3271
Status:	Technical report/Recommendation
Publisher:	European Broadcasting Union (EBU)
Date of Publication:	1993
Description:	This standard specifies basic parameters for HDTV production standard for 1250/50/1:1 and 1:2 implementations (in Europe).

It is based on ITU-R BT.709 (formerly CCIR Rec. 709).

Editor/Point-of-Contact:	EBU Working Party V V
Address:	European Broadcasting Union Case postale 1283 Berne, 3001 Switzerland
Telephone/Fax:	+41-31-622-080 +41-31-622-078
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WWW URL:	

ITU-R BT.709

Standard:	Basic Parameter Values For The HDTV Standard For The Studio And For International Programme Exchange - Section 11A - Characteristics of Systems for Monochrome and Colour Television
Designation:	ITU-R BT.709 (formerly CCIR Recommendations 709)
Status:	ITU Recommendation
Publisher:	ITU
Date of Publication:	1990
Description:	The parameters in this recommendation are to be used to generate signals in high-definition television studios and for international exchange of HDTV programs.
Editor/Point-of-Contact:	
Address:	ITU-R (formerly CCIR International Radio Consultative Committee) CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

MIL-STD-1379D

Standard:	Military Training Program Standards
Designation:	MIL-STD-1379D
Status:	DoD, Formal
Publisher:	DoD
Date of Publication:	1990
Description:	This DoD Standard is based on the IMA "Recommended Practices for Multimedia Portability," version 1.1, which represents IMA's recommendations for command and interface mechanisms used in Level-three Interactive Video (IV) systems. This standard includes both audio and video specifications. There also is a specification under development for an API Laser Disc- Based Delivery System.
Editor/Point-of-Contact:	Brian Marquardt, IMA Technical Compatibility Manager
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NTSC

Standard:	National Television Standards Committee (NTSC)
Designation:	ITU-R Report 624-4 (formerly, CCIR Rep. 624-4)
Status:	Report
Publisher:	ITU-R (formerly CCIR)
Date of Publication:	1990
Description:	NTSC is the current analog television format used in the U.S. and Japan. CCIR Rep. 624 describes the basic parameters of NTSC.
Editor/Point-of-Contact:	
Address:	ITU-R (formerly, CCIR International Radio Consultative Committee) CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URLs:	**http://www.itu.ch/**

PAL

Standard:	PAL (Phase Alternating Line), Video Cameras (PAL/SECAM/NTSC) - Methods of Measurement - Part 1: Non-Broadcast, Single-Sensor Cameras, First Edition
Designation:	IEC 1146; ITU-R Report 624-4
Status:	Report
Publisher:	IEC; ITU
Date of Publication:	1994
Description:	PAL is a current European analog television format. Different versions are used in Australia and New Zealand, China, Brazil, and Argentina. This part of IEC 1146 is applicable to the assessment of performance of non-broadcast color video cameras equipped with a single-tube or solid-state imager. It defines test patterns and measurement conditions, so as to make possible the comparison of the results of measurements. The methods of measurement are designed to make possible the assessment of the performance of the camera by using the lens input and are electrical output terminals of the device.
Editor/Point-of-Contact:	
Address:	International Electrotechnical Commission (IEC) Central Office CH-1211 Geneva 20 Switzerland
Telephone/Fax:	
E-mail address:	**telnet iec.iec.ch**
WWW URL:	**http://www.hike.te.chiba-u.ac.jp/ikeda/IEC/84/1146-1.html**

SECAM

Standard:	SECAM (Sequential Couleur avec Memoire)
Designation:	ITU-R Report 624-4 (formerly, CCIR Report 624-4)
Status:	Report
Publisher:	ITU-R (formerly, CCIR)
Date of Publication:	1994
Description:	SECAM is an analog television format used in France, CIS, Eastern Europe, and parts of Africa and the Middle East. CIR Rep. 624 describes the basic parameters of SECAM. All television systems listed in this report employ an aspect ratio of the picture display (width/height) of 4/3, a scanning sequence from left to right and from top to bottom, and an interlace ratio of 2/1, resulting in a picture (frame) frequency of half the field frequency. All systems are capable of operating independently of the power supply frequency.
Editor/Point-of-Contact:	
Address:	ITU-R (formerly, CCIR International Radio Consultative Committee) CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

SMPTE 240M **Standard:**	Society for Motion Picture Television Engineers (SMPTE) - Signal Parameters - 1125-Line High-Definition Production Systems
Designation:	SMPTE Standard 240M
Status:	de facto
Publisher:	SMPTE
Date of Publication:	1994
Description:	This standard defines the basic characteristics of the video signals associated with origination equipment operating in the 1125/60 high-definition television production system. It defines the analog parameters for the 1125/60/1:2 system, which was originally produced by Sony. Additional SMPTE standards are: 1) SMPTE 244M, Television - System M/ NTSC Composite Video Signals - Bit-Parallel Digital Interface (1993) 2) SMPTE 259M Television - 10-Bit 4:2:2 Component and 4fsc NTSC Composite Digital Signals - Serial Digital Interface (1993) 3) SMPTE 261M, Television - 10-Bit Serial Digital Television Signals: 4:2:2 Component and 4fsc NTSC Composite - AMI Transmission Interface
Point-of-Contact:	Sherwin H. Becker Director of Engineering
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APPENDIX A.5

VIDEO, DIGITAL

A.5 VIDEO, DIGITAL

IMPACT OF STANDARDS ON THE USE OF DIGITAL VIDEO

INTRODUCTION: This section addresses the impact of standards on the use of Digital Video in several different aspects. Each is discussed briefly below:

Motion video and graphic mixes: When mixing digitized motion video (in a window) and graphics or text, a color shift may occur in the graphic or background. When this occurs, the video will override and change the colors in the background or graphic. The colors reserved for the video must not be used in other applications and color numbers must not be assigned the same values. This is a classic case where a lack of standardization impacts product development.

Digital image processing: SMPTE has a working group on Digital Image Architecture (WGDIA) to define a common digital image-processing environment for both next-generation digital TVs and multimedia-based desktop computers. Currently, there are numerous image-creation systems with incompatible file formats.

Desktop videoconferencing (see also Appendix A.7): 1) Point-to-point (over dial-up telephone system), 2) multipoint systems (up to 4 points), 3) multipoint systems (up to 8 points). These systems require bandwidth management. Asynchronous Transfer Mode (ATM) on a Wide Area Network (WAN) is functional. However, at least seven vendors offer ATM WAN products with no standard to ensure interoperability. To interact with another site, all sites must use the same standard. Desktop videoconferencing applications are expected to grow rapidly within the next few years. Although ITU-T standards are emerging (see Appen dix A.7), implementations are vendor-specific.

Video file storage requirements: A digital image is a two-dimensional array of values representing intensity or color on a grid. The numbers can be as simple as 0 and 1, for black and white, or they can be 8 bits for gray-scale values, or 24 bits for color. The amount of file space required varies with the amount of information included in the file. Text may require 3 KB of storage; 16-bit stereo sound requires almost 200 KB of data per second; and full-motion, 16-bit color video requires over 18 MB per second. A major challenge is to compress the information to fit into the limited bandwidth available on current computer buses, LAN and WAN, and cable-television schemes (see Chapter 10).

Video on compact disk (see also Appendix A.7): Film and video on television require playback frame rates of 24 or 30 frames per second, respectively. Each frame contains a full monitor screen of color information, which for VHS video means 32,768 colors. These 32,768 possible color points, at a screen resolution of 342x240, repeated 30 times per second, can result in a storage requirement of some 5MB per second of video. A com pact disc can only hold 136 seconds or 2.2 minutes of uncompressed VHS-quality video. Disk access speed, 154KB of data per second, falls short of the 5MB stream needed per second for uncompressed VHS video. The video data stream has to be no larger than the 154KB bandwidth can handle. The combined compressed audio and video stream must fit the maximum 1.2MB per second (equivalent to 150KB per second) to fit the CD-ROM bandwidth of 150KB per second.

Software only - video playback: Software-only playback uses the computer processor to decompress the video files without additional hard-ware support. The current status of *software-only* technology can produce 1/4 screen .30fps video of good quality when using a Pentium processor and a 32-bit+, windows video accelerator graphics card. A 486 with 256 color capability can only produce marginal " postage stamp" quality for 1/4 screen size at approximately 10 to 15 fps. Software only - video playback is generally used for training, presentations, and desktop video conferencing, when the user community is dispersed and may not possess dedicated video-decoding hardware. It is also used for multimedia publishing.

Hardware-assisted playback (see also Appendix A.7): Computers have add-on hardware boards with dedicated, fast video DSP chips to decompress and display better-quality digital video.

Different hardware-assisted compression standards are listed below:

- **Interframe compression**: Uses combinations of key, motion-pre-dicted, and interpolated frames to achieve high-compression ratios and low data rates. Product examples are:

- • **Production Level Video (PLV)**: PLV is part of DVI technology. PLV provides VHS-quality video at 30 fps on a full-screen display. Resolution is 256x240. Interpolation is used to achieve a full VGA screen 640x480 display.

- • **MPEG algorithms**: MPEG uses three types of frame: (I)ntra picture, (P)redicted, and (B)idirectional. There are two MPEG standards:

  - **MPEG-1**: full-motion, full-frame video playback from a CD-ROM at 1.2MB/s. Audio rates up to 1.5 MB/s. Quality comparable to VHS.

  - **MPEG-2**: high-quality video delivery in broadcast and production applications. ITU-R BT.601 resolution and data rates from 2MB/s to 20MB/s. Will be used for HDTV.

  - **MPEG-4:** an emerging coding standard that supports new ways (notably content-based) for communication, access, and manipulation of digital audio-visual data.

- **Intraframe compression**: Compresses every frame (sometimes every field) individually and provides quality video with the advantage of frame-accurate editability. Data rate is 2 to 10 times higher than interframe algorithms. Product examples are:

  - • **TrueMotion**: Requires a compression board. Provides intraframe-only compression at 640x480 playback resolution on a VGA monitor. Video appears similar to that from a laser video disc.

  - • **Motion JPEG**: Joint Photographic Experts Group standard for still image compression uses the Discrete Cosine Transform (DCT) algorithm. High data rate and storage requirements put great demands on drives, buses, and processors. It is not used much for distributed multimedia. JPEG was standardized for still images, but there is no associated audio processing standard nor synchronization technique for Motion JPEG. Manufacturers have adopted different audio techniques, resulting in unique bitstreams that are not compatible with those of other vendors. This limits distributed environment use, but JPEG is usually accepted for closed-environment applications, such as video editing.

In general, an increased compression ratio results in decreased quality, reduced file size, and limited system throughput. It is necessary to define what is impor tant: final image quality or, storing large amounts of information in limited space.

Other video considerations are whether the software/hardware include a flicker filter, color correction (NTSC-safe colors), key channel control, or gamma adjustment. Table IV shows factors that impact consideration of a compression format.

The goal is to increase network bandwidth or to reduce the amount of video bandwidth. To reduce bandwidth demand, you must limit the traffic that multimedia applications generate. For minimum demand, select an interframe compression standard in conjunction with reduced picture resolution, smaller picture windows, and slower video frame rates.

Table IV. Video Codecs in Comparison

Method/ Product	Frame Rate (FPS)	Data Rate (kilobits)	Resolution	Audio Synch	Special Hardware	Compression	Quality
Ultimotion	15	150	160 x 120	Yes	None	Symmetric	Low
QuickTime	15 -24	150	320 x 240	Yes	None	Asymmetric 150:1	Low-Medium
RTV	30	150	128 x 240	Yes	Yes	Symmetric	Low-Medium
INDEO	15 - 30	150 - 500	160 x 120 (320 x 240)	Yes	None	Symmetric & Asymmetric	Medium
PLV	30	15 - 300	256 x 240 (512 x 480)	Yes	1750	Asymmetric 45:1	Medium-High
MPEG-1	30	150	352 x 240	Yes	CL450/950	Asymmetric 15:1 to 500:1	Medium-High
MPEG-2	30	150 -2000	720 x 480	Yes	CLR-4000	Asymmetric	Very High
Motion JPEG	30	600 -1500	640 x 480	No	CL550/560	Asymmetric	High
TrueMotion	30	600	640 x 480	Yes	1750	Asymmetric (5:1)	Very High
Cinepak	15-24	150	160 x 120 (320 x 240)	Yes	None	Asymmetric	Low-Medium
Laser Video-Disc	30	22,700	640 x 480 (450 horizontal lines)	Yes	Videodisc Player	N/A	Very High

From Desktop Video World, March 94, pg. 42. (Modified). Revised from IMA Interactive Multimedia News, March-April 1995, p. 25

D-1

Standard:	Television Digital Component Recording - 19mm Type D-1
Designation:	SMPTE Standard 224M - Tape Record SMPTE Standard 225M - Magnetic Tape SMPTE Standard 226M - Tape Cassette SMPTE Standard 227M - Helical Data and Control Records SMPTE Standard 228M - Time and Control Code and Cue Records
Status:	Industry, de facto
Publisher:	SMPTE
Date of Publication:	1993
Description:	Digital Video Tape Format for Production (component) 19mm

D-1 is component video using 30 (525/NTSC) or 25 (625/PAL) interlaced ITU-R 601 4:2:2 fps with 8 bits sample precision. Tape format is based upon metal particle, 19mm (looks like a U-matic cassette). Active video bit rate is 167 Mbit/sec. D-1 is the official MPEG format for experimentation.

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WWW URL:	**http://www.smpte.org**

D-2

Standard:	Television Digital Recording - 19mm Type D-2 Composite Format
Designation:	SMPTE Standard 245M - Tape Record SMPTE Standard 246M - Magnetic Tape SMPTE Standard 225M - Magnetic Tape SMPTE Standard 247M - Helical Data and Control Records SMPTE Standard 248M - Cue Record and Time and Control Code Record
Status:	Industry, de facto; ANSI
Publisher:	SMPTE
Date of Publication:	1993
Description:	Digital Video Tape Format for Production (composite) 19mm

D-2 is composite video sampled at 4 times the color subcarrier (3.58 MHz or 4.43 MHz) of NTSC/PAL, respectively with 8 bits sample precision. Same cassette shell as D-1. Active rate around 85 (NTSC) and 110 Mbit/sec (PAL).

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D-3

Standard:	Television Digital Recording - 1/2-in Type D-3 Composite Format
Designation:	SMPTE Standard 263M - Tape Cassette SMPTE Standard 264M - 525/60 SMPTE Standard 265M - 625/50 SMPTE Standard 266M - Digital Vertical Interval Time Code
Status:	Industry, de facto
Publisher:	SMPTE
Date of Publication:	1993
Description:	Digital Video Tape Format for Production (composite) 1/2 in

D-3 uses the same sampled signal as D-2, only the tape format is based on 1/2" (12.5mm).

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D-5

Standard: Television Digital Recording - 1/2 in Type D-5 Component Format

Designation:

Status: Industry, de facto

Publisher: SMPTE

Date of Publication:

Description: Digital Video Tape Format for Production (component) 1/2 in

D-5 is component video like D-1, only with 10 bits sample precision and it uses the D-3 tape format. Active rate is about 210 Mbit/sec.

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ITU-R BT.601-2

Standard:	Encoding Parameters of Digital Television for Studios - Section 11F - Digital Methods of Transmitting Television Information
Designation:	ITU-R BT.601-2
Status:	Formal Recommendation
Publisher:	ITU-R (formerly, CCIR)
Date of Publication:	1990
Description:	ITU-R BT.601-2 is used as a basis for digital coding standards for television studios in countries using the 525-line system as well as in those using the 625-line system. It specifies the sampling parameters, coding, and relationship between analog and digital values.
Editor/Point-of-Contact:	ITU-R Study Group 11
Address:	ITU-R (formerly, CCIR International Radio Consultative Committee) CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+41-22-730-5554 +41-22-730-5337 (fax)
E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

SMPTE 1

Standard:	Video Recording-2-in Magnetic Recording Tape
Designation:	SMPTE 1
Status:	Industry, de facto; ANSI
Publisher:	SMPTE
Date of Publication:	1990; Revision and redesignation of ANSI C98.1-1978
Description:	
Point-of-Contact:	Sherwin H. Becker Director of Engineering
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WWW URL:	**http://www.smpte.org**

SMPTE 4

Standard:	Television Analog Recording - 2-in Magnetic Tape for Quadruplex Recording - Speed
Designation:	SMPTE 1
Status:	Industry, de facto; ANSI
Publisher:	SMPTE
Date of Publication:	1989; Revision and redesignation of ANSI C98.4-1983
Description:	
Point-of-Contact:	Sherwin H. Becker Director of Engineering
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WWW URL:	**http://www.smpte.org**

SMPTE 260M

Standard:	Television - Digital Representation and Bit-Parallel Interface - 1125/60 High-Definition Production System
Designation:	SMPTE Standard 260M
Status:	Industry, de facto; ANSI
Publisher:	SMPTE
Date of Publication:	1992
Description:	This standard specifies the digital representation of the signal parameters of the 1125/60 high-definition production system as given in their analog form by SMPTE 240M-1988.
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WWW URL:	**http://www.smpte.org**

APPENDIX A.6

AUDIO, DIGITAL

A.6 AUDIO, DIGITAL

IMPACT OF STANDARDS ON THE USE OF DIGITAL AUDIO

There are at least a dozen methods to represent and synthesize audio in digital form, and at least as many proposals for how to compress and decompress the digitized audio. The International Multimedia Association (IMA) is trying to narrow the number of allowable types of digital audio standards. To this end, it issued a Recommended Practice for Enhancing Digital Audio Compatibility in Multimedia Systems in 1994.

Other considerations are affected by standards: Is mono- or stereo-sound required; is single track or dual track needed; what level of sound quality is required (music requires higher fidelity than voice); and what other uses may be made of the second track (for example, to put narration in a second language or to encode synchronization code to run with digital video). Each decision affects the size of the file that is generated and the fidelity of the playback. Table V summarizes factors to consider when choosing audio standards.

Table V. Digital Audio File Size vs Quality

Sampling Rate	Resolution	Stereo	Bytes/ Minute	Quality
44.1 kHz	16-bit	stereo	10.5 MB	best CD
44.1 kHz	16-bit	mono	5.25 MB	good
44.1 kHz	8-bit	stereo	5.25 MB	best PC
44.1 kHz	8-bit	mono	2.6 MB	best PC
22.05 kHz	16-bit	stereo	5.25 MB	good CD
22.05 kHz	16-bit	mono	2.6 MB	speech OK
22.05 kHz	8-bit	stereo	2.6 MB	popular
22.05 kHz	8-bit	mono	1.3 MB	usable
11 kHz	8-bit	stereo	1.3 MB	poor stereo
11 kHz	8-bit	mono	650 MB	low as can go
5.5 kHz	8-bit	stereo	650 MB	not effective
5.5 kHz	8-bit	mono	325 MB	bad phone!

OEM Magazine, February 1994

Some sound file formats are Musical Instrument Digital Interface (MIDI), Microsoft Waveform (WAVE), Compact Disk - Digital Audio (CD-DA), and AIFF. MIDI is exclusively for digitally generated music; WAVE is used for sound, music, and voice. CD-DA defines the use of compact disk for audio files, including music. AIFF, for the Macintosh, is an example of a proprietary format.

As with other media, playback compatibility is a factor. For example, Soundblaster is becoming a *de facto* standard hardware solution for Windows or DOS environments. Any delivery (playback) platform chosen must support the standards of the development platform that was used.

CD-DA

Standard:	Compact Disc - Digital Audio (CD-DA) System
Designation:	IEC 908
Status:	IEC, Formal
Publisher:	IEC; ANSI
Date of Publication:	1987
Description:	Specification known as Red Book, originally developed by Sony and Phillips. A CD-ROM drive that can also be used to play music discs as long as the drive has the appropriate audio decoding circuits.
Editor/Point-of-Contact:	
Address:	International Electrotechnical Commission (IEC) Central Office CH-1211 Geneva 20 Switzerland
Telephone/Fax:	
E-mail address:	**telnet iec.iec.ch**
WWW URL:	**http://www.hike.te.chiba-u.ac.jp/ikeda/IEC/84/1146-1.html**

IMA DIGITAL AUDIO

Standard:	IMA Recommended Practices for Enhancing Digital Audio Compatibility in Multimedia Systems
Designation:	DP-DA version 3.0
Status:	Industry, Informal
Publisher:	IMA
Date of Publication:	Fall 1994
Description:	Limited set of audio formats that are guaranteed to be supported on any IMA audio compliant platform. These formats are required to provide baseline digital audio cross-platform support to satisfy a range of audio quality and data bandwidth requirements.
Editor/Point-of-Contact:	Brian Marquardt
Address:	Interactive Multimedia Association 3 Church Circle, Suite 800 Annapolis, MD 21401-1933
Telephone/Fax:	410-675-2093 410-263-0590 (fax)
E-mail address:	**71431.3312@compuserve.com**
WWW URL:	**http://www.ima.org**

ITU-T G.711

Standard:	Pulse Code Modulation (PCM) of Voice Frequencies
Designation:	ITU-T G.711
Status:	ITU Recommendation, Formal
Publisher:	ITU (formerly CCITT)
Date of Publication:	June 1990
Description:	ITU-T G.71 is for standard digital telephony audio. It uses a sampling rate 8kHz, mono, and a data format 8-bit mu-Law/A-Law Pulse Code Modulation (PCM) of voice frequencies. 64 kbit/s 8kHz 8 bit PCM audio encoding.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch**

<u>ITU-T G.722</u>

Standard:	7 kHz audio-coding within 64 kbit/s
Designation:	ITU-T G.722
Status:	ITU-T Recommendation, Formal
Publisher:	ITU (formerly CCITT)
Date of Publication:	1988; June 1990
Description:	G.722 codes wideband digital audio on a 64kbps link (7 kHz to 64 kbps using ADPCM).
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch**

ITU-T G.726

Standard: 40, 32, 24, 16 kbit/s adaptive differential pulse code modulation (ADPCM) [PN: G.721 + G.723]; Extensions of Recommendation G.726 on 40, 32, 24, 16 kbit/s adaptive differential pulse code modulation for use with uniform-quantized input and output (Annex to G.726); Appendix III to Recommendation G.726 - Comparison of ADPCM algorithms (Note - Same as Appendix II to Rec. G.727)

Designation: ITU-T G.726 (formerly G.721); G.726 A; G.726

Status: ITU Recommendation, Formal

Publisher: ITU (formerly CCITT)

Date of Publication: 1990; G.726 (April 1991); G.726A (June 1995); G.726 III (May 1995)

Description: ITU G.726 sets out the characteristics that are recommended for the conversion of a 64 kbit/s A-law or μ-law PCM channel to and from a 40, 32 ,24, 16 kbit/s channel. The conversion is applied to the PCM bit stream using an ADPCM transcoding technique. The relationship between the voice frequency signals and the PCM encoding/decoding laws is fully specified in Recommendation G.711. It provides first an outline description of the ADPCM transcoding algorithm, then the principles and functional descriptions of the ADPCM encoding and decoding algorithms respectively, and finally, the precise specification for the algorithm computations. Networking aspects and digital test sequences are address also in Recommendation G.726.

Editor/Point-of-Contact:

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WWW URL: **http://www.itu.ch**

ITU-T G.728

Standard:	Coding of speech at 16 kbit/s using low-delay code excited linear prediction; 16 kbit/s fixed point specification (Annex to G.728)
Designation:	ITU-T Recommendation G.728
Status:	ITU-T Recommendation
Publisher:	ITU-T
Date of Publication:	December 1992; Annex (June 1995)
Description:	Coding of speech at 16 kbit/s using low-delay code excited linear prediction; 16 kbit/s fixed point specification (Annex to G.728)
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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WWW URL:	**http://www.itu.ch/**

MIDI

Standard:	MIDI (Musical Instrument Digital Interface Standard)
Designation:	MIDI 1.0 (document v.4.2)
Status:	Industry *de facto* standard
Publisher:	MIDI Manufacturers Association
Date of Publication:	January 1995 (Version 95.1)
Description:	MIDI is a public domain asynchronous serial protocol for transmitting descriptive performance information in low to medium bandwidth electronic musical instruments and related audio/visual equipment. The specification covers musical events, time events, machine (transport) control, show (lighting and other device) control, and file transport. The desire was to develop a unified hardware/software specification that allowed remote control of instruments so that users could mix and match as well as automate their own personalized music studios or performance environments. The Complete MIDI 1.0 Detailed Specification book published by the MMA (Copyright 1995) includes six documents: - MIDI 1/0 Specification v.4.2 - MIDI Machine Control 1.0 - MIDI Show Control 1.0 - MIDI Time Code - General MIDI System Level 1 - Standard MIDI Files 1.0
Editor/Point-of-Contact:	Tom White
Address:	MIDI Manufacturers' Association P.O. Box 3173 La Habra, CA 90632
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E-mail address:	**MMA@pan.com** or **mma@earthlink.net**
WWW URL:	

Rio-1

Standard:	8 kbit/s Voice Coder
Designation:	Rio-1
Status:	ITU emerging recommendation
Publisher:	ITU
Date of Publication:	late 1995
Description:	Work on this coder begun some five years ago in Brazil (hence its nick-name Rio-1), where the technical requirements for such a standard were defined in detail. Selection of this coder represents a significant technological achievement. Up to now, toll-quality voice was not deemed possible at rates below 16 kbit/s, which in itself, was a breakthrough only four years ago. The selection of the 8 kbit/s ACS-CELP (Rio-1) coder is more than a mere technological achievement, however. The ability to offer high-quality voice at 8 kbit/s makes possible interoperable digital multimedia and wireless communication services to be offered on a global basis. For wireless applications, the ability to transport voice over increasingly narrower bandwidths, or to do so while utilizing lower signal strengths frees more spectrum for other applications and allows more users to share essentially the same transmission facilities. This permits end-user prices to be reduced, service levels to be increased and telecommunications access to be more broadly offered while bringing personal communications services, or PCS, closer to reality.
Editor/Point-of-Contact:	Spiros Dimolitsas, Chair ITU-T Working Party 2/15-Signal Processing
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APPENDIX A.7

VIDEO/AUDIO MIX

A.7 VIDEO/AUDIO MIX

IMPACT OF STANDARDS ON THE USE OF VIDEO WITH AUDIO

Video conferencing: ITU-T H.320 standard for real-time videoconferencing requires decoding hardware at playback stations because it uses a complex discrete-cosine-transform algorithm to compress content. If the receive site does not have compatible hardware, the video cannot be decoded. Compression/decompression can be handled through software or hardware in the following combinations:

Compression	Decompression
Software	Software
Software	Hardware
Hardware	Hardware
Hardware	Software

Compression by software requires more time than decompression and is therefore called an asymmetric process. The main benefit to hardware compression is to achieve a symmetric system. Software decompression does not require special hardware, however, the type and speed of CPU are significant. Moreover, some argue that picture quality degrades rapidly with software decompression. Hardware decom pression is necessary if full screen, full motion video is needed. Indeo, by Intel, is an example of a CODEC that uses hardware for real-time compression and software for decompression. Cinepak is another example. Both use vector quantization (VQ) algorithms. Software-only codecs are crucial for squeezing huge digital video files through communications pipelines. On the software-side, it is replacing Intel's DVI, a hardware-based codec.

Several video conferencing manufacturers have given priority to document sharing and shared white boards over video pictures. As a result, ITU-T's T.120 standards describe ways of sharing applications without moving video images. The ITU-T T.120 standard defines protocols and APIs for cross-platform whiteboarding, pointing, annotation, binary file transfer, and even application sharing - all in a multi-point environment using heterogeneous networks.

While ITU-T H.320 can handle WAN-based video conferencing, it is inadequate for LANs. Other ITU-T standards, as shown in Table VI below handle LANS. Two proprietary compression schemes for LANs are Novell's

VideoWare 1.0 and PictureTel's LiveLAN. Two QoS standards candidates for transporting video streams across LAN routers are ST-2 and IP-Multicast. ST-2 is an adopted experimental IETF protocol. IP Multicast was adopted by IETF in 1992 and acquired the name MBONE, which stands for Virtual Internet Backbone for Multicast IP at that time.

Annex B of VTC-001, the Corporation for Open Systems' Industry Profile for Video Teleconferencing contains additional DoD information and optional specifications. The Profile replaces MIL-STD-188-331 and 188-331A, Interoperability and Performance Standard for VTC. Moreover, the international standards cited in the Profile are fully interoperable with the federal standard for VTC, FIPS 178.

Table VI. Video Teleconferencing Standards

	Narrow-band VTC (H.320)	Low Bitrate VTC (H.324)	Iso - Ethernet VTC (H.322)	Ethernet VTC (H.323)	ATM VTC (H.321)	High Res ATM VTC (H.310)
Video	H.261	H.261 H.263	H.261	H.261 H.263	H.261	MPEG-2 H.261
Audio	G.711 G.722 G.728	G.723	G.711 G.722 G.728	G.711 G.722 G.723 G.728	G.711 G.722 G.728	MPEG-1 MPEG-2 G.7xx
Data	T.120	T.120 T.434 T.84 Others	T.120	T.120	T.120	T.120
Multilplex	H.221	H.223	H.221	H.22z	H.221	H.222.1 H.221
Signalling	H.230 H.242	H.245	H.230 H.242	H.230 H.245	H.230 H.242	H.245
Multi-point	H.243		H.243		H.243	
Encryption	(in draft revision) H.233 H.234	H.233 (adapted in H.324) H.234	(By refer-ence to H.320)	TBD	H.233 H.234	

From Video Teleconferencing Standards, briefing by Gary A. Thom, Delta Information Systems, (215) 657-5270

Interleaving audio and video: Apple QuickTime and Microsoft Video for Windows define separate specifications for interleaving and synchronizing audio and video signals as part of multimedia packages.

The Video for Windows specifications are hardware dependent. Until an interoperable version is available, both the developer and end-user must have the same configuration.

QuickTime cross-platform development versions are available. A multimedia program can be developed in any of several formats. The playback equipment must match the output format selected for the development system.

A compression standard that supports the audio playback capability in the end-user system must be chosen. Video for Windows AVI (Audio Video Interleaved) audio will play through Microsoft Waveform (WAVE) compatible audio cards. The video and audio portions of the stream are processed separately. AVS (Audio Video Synchronization) (DVI audio) is processed out of the decompression card with the video. Other digital video systems use the internal Windows sound capability. For successful playback, the standard used to create the audio/video must match it in the playback hardware.

CD-I

Standard: CD-I (Compact Disk Interactive)

Designation: CD-I

Status: Vendor

Publisher: Sony, Phillips and Microware

Date of Publication: 1987

Description: CD-I Compact Disk Interactive is commonly known as the Green Book. It is a single media system that contains images, sound, graphics, and all the necessary programs to display and interact with the different content data types. CD-I uses ISO 9660 standards and CD-ROM XA specifications.

Editor/Point-of-Contact: Paul Holmes

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5623 Spring Grove Drive
Solon, OH 44139

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WWW URL:

CD-ROM-XA

Standard:	CD-ROM Extended Architecture
Designation:	CD-ROM-XA
Status:	Industry
Publisher:	Microsoft
Date of Publication:	1986
Description:	CD-ROM -XA consists of Microsoft extensions of the Yellow Book and a bridge between CD-ROM and CD-I. It uses elements of the Green Book (CD-I) that are consistent with ISO 9660.
Editor/Point-of-Contact:	Jim Green
Address:	Microsoft One Microsoft Way Redmond, WA 98052
Telephone/Fax:	206-882-8080 206-883-8101 (fax)
E-mail address:	
WWW URL:	**http://www.microsoft.com**

DVI

Standard:	Digital Video Interactive
Designation:	DVI
Status:	Vendor
Publisher:	Intel Corporation
Date of Publication:	July 1989
Description:	DVI was Intel's original name for its PC-based digital video technologies. It was available on the PC/AT at minimum running MS-DOS, known as ActionMedia, and was composed of three main subsystems: the Real-Time Executive, the Audio/Video Subsystem, and a special graphics library. In April 1995, it was replaced on the software side with Indeo video technology, on the retail side with Smart Video Recorder, and on the hardware side with I750 (R) processors.
Editor/Point-of-Contact:	
Address:	Intel Corporation 313 Enterprise Drive Plainsboro, NJ 08536
Telephone/Fax:	
E-mail address:	**dvi-list@calvin.dgbt.doc.ca**
WWW URL:	**http://www.intel.com**

FIPS 178-1

Standard:	Video Teleconferencing Services at 56 to 1,920 kb/s
Designation:	FIPS 178-1
Status:	U.S. Government Federal Information Processing Standard (FIPS) DRAFT
Publisher:	National Institute of Standards and Technology
Date of Publication:	20 June 1995
Description:	This standard, by adoption of ITU-T Recommendations H.320, H.221, H.242, H.261, H.230, H.231, H.243, H.233, H.234, and H.244 defines the specifications for video teleconferencing, video telephony systems, including multipoint control units, and privacy. It provides Federal departments and agencies a comprehensive description of the interoperability criteria for audiovisual systems used in video teleconferencing and videophone applications. Many ITU-T Recommendations specify service from 64 kb/s through 1,920 kb/s, and some ANSI standards specify service from 56 kb/s through 1,536 kb/s. To avoid confusion on applications within the Federal Government involving both national and international interoperability, this standard encompasses both ranges of data rates to specify service from 56 kb/s through 1,920 kb/s. Most standard data networks in the U.S. carry data from 56 kb/s to 1,536 kb/s.
Editor/Point-of-Contact:	Gary M. Rekstad
Address:	National Communications System NC-TS 701 S. Court House Road Arlington, VA 22204-2198
Telephone/Fax:	703-607-6195 703-607-4830 (fax)

E-mail address: **rekstadg@cc.ims.disa.mil**

INDEO

Standard:	Intel video compression standard
Designation:	Indeo
Status:	Vendor, Proprietary
Publisher:	Intel Corporation
Date of Publication:	
Description:	This is Intel's compression/ decompression algorithm for scalable software playback video. Intel licenses Indeo technology to companies such as Microsoft that integrate it into products such as Microsoft's Video for Windows. Indeo technology can record 8-, 16-, or 24-bit sequences and store the sequence as 24-bit for scalability on higher power PCs. It replaces DVI as of April 1995.

A proprietary blend of color subsampling, pixel differencing, vector quantization, and run-length encoding. Indeo, which in the past relied on an 1720 chip set for decompression, now plays back on consumer platforms without any additional hardware.

Indeo video files can be decompressed on a wide range of personal computers. The quality of video will vary depending on the power of the central processing unit (CPU) in the computer used for playback, or if there is an I750 video processor-based board present for playback. Basically, the higher the processor speed, the better the video quality.

Indeo video has been created to allow virtually anyone with a personal computer to play video, and anyone with an I750 video processor-based board to create video in one easy step. Indeo video introduces the notion of "scalable performance" to multimedia. This feature, unique to Indeo video software, allows the video playback to adapt to the performance of the hardware available in the computer, without requiring the user to ever change the software or the video file itself. Therefore, the quality of the video playback is scaled to the system performance.

Editor/Point-of-Contact:	Indeo Support Group
Address:	Intel Corporation 2111 NE 25th Avenue Hillsboro, OR 97124
Telephone/Fax:	503-264-8080
E-mail address:	
WWW URL:	**http://www.intel.com**

ITU-T H.120

Standard:	Codecs for Videoconferencing Using Primary Digital Group Transmission - Line Transmission of Non-telephone Signals - Transmission of Sound-programme and Television Signals (Study Group 15)
Designation:	H.120
Status:	Recommendation, Formal
Publisher:	ITU-T
Date of Publication:	April 1994
Description:	H.defines codecs for videoconferencing using primary digital group transmission - line transmission of non-telephone signals - transmission of sound-programme and television signals. It was developed by Study Group 15. **Editor/Point-of-Contact:**
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.221

Standard:	Frame structure for a 64 to 1920 kbit/s channel in audiovisual teleservices.
Designation:	ITU-T H.221
Status:	Recommendation, Formal
Publisher:	ITU-TS
Date of Publication:	April 1994 (Revision 2)
Description:	H.221 defines a frame structure for audiovisual teleservices in single or multiple B or H0 channels or a single H11 or H12 channel that uses the characteristics and properties of audio and video encoding algorithms, transmission frame structure, and existing recommendations. It has several advantages: It considers Recommendations G.704, X.301/I.461, etc. It may allow the use of existing hardware and software. It is simple, economic, and flexible. It may be implemented on a single microprocessor using well-known hardware principles. It is a synchronous procedure. The exact time of a configuration change is the same in the transmitter and the receiver. It needs no return link for audiovisual signal transmission since a configuration is signalled by repeatedly transmitted codewords. It is very secure in case of transmission errors since the code controlling the multiplex is protected by double-error correcting code. It allows synchronization of multiple 64 Kbit/s or 384 Kbit/s connections and the control of the multiplexing of audio, video, data and other signals within the synchronized multiconnection structure in the case of multimedia services such as videoconferencing. It can be used in multipoint configurations where no dialogue is needed to negotiate the use of a

data channel. It provides a variety of data bit-rates (from 300 b/s up to almost 2 MB/s) to the user. H.221 is closely related to H.261 & H.242. It supersedes H.220.

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ITU-T H.224

Standard:	A real time control protocol for simplex applications using the H.221 LSD/HSD/MLP channels
Designation:	ITU-T H.224
Status:	ITU-T Recommendation
Publisher:	ITU-T
Date of Publication:	May 1995
Description:	ITU-T H.224 defines a real time control protocol for simplex applications using the H.221 LSD/HSD/MLP channels.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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WWW URL:	**http://www.itu.ch/**

ITU-T H.230

Standard:	Frame-synchronous control and indication signals for audiovisual systems
Designation:	ITU-T H.230
Status:	ITU-T Recommendation, Rev. 1
Publisher:	ITU-T
Date of Publication:	1993; February 1994
Description:	Video telephony over narrowband ISDN is governed by a suite of ITU-T interoperability standards. The overall video telephony suite is known informally as p * 64 (and pronounced 'p star 64'), and formally as standard H.320. H.320 is an "umbrella" standard; it specifies H.261 for video compression, H.221, H.230, and H.242 for communications, control, and indication, G.711, G.722, and G.728 for audio signals, and several others for specialized purposes. A common misconception, exploited by some equipment manufacturers, is that compliance with H.261 (the video compression standard) is enough to guarantee interoperability. H.230 provides additional frame-synchronous control and indication signals such as freeze picture, video loopback, and simple multipoint controls. These control and indication signals are necessary to provide additional functionality and to provide extensibility to future standards.
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ITU-T H.242

Standard:	System for Establishing Communication Between Audiovisual Terminals Using Digital Channels up to 2Mbit/s
Designation:	ITU-T Recommendation H.242
Status:	ITU-T Recommendation
Publisher:	ITU
Date of Publication:	Rev. 1 April 1994
Description:	This standard is for a system for establishing communication between audiovisual terminals using digital channels up to 2Mbit/s.
Editor/Point-of-Contact:	
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WWW URL:	**http://www.itu.ch/**

ITU-T H.261

Standard:	Video codec for audiovisual services at p x 64 kbit/s
Designation:	ITU-T H.261
Status:	Recommendation, Formal
Publisher:	ITU-TS
Date of Publication:	February 1994 (Revision 2)
Description:	Recommendation H.261 describes the video coding and decoding methods for the moving picture component of audiovisual services at the rate of p x 64 kbit/s, where p is the range 1 to 30. It describes the video source coder, the video multiplex coder, and the transmission coder. This standard is intended for carrying video over ISDN - in particular for face-to-face videophone applications and for videoconferencing. Videophone is less demanding of image quality and can be achieved for p=1 or 2. For videoconferencing applications (where there are more than one person in the field of view), higher picture quality is required and p must be at least 6. H.261 defines two picture formats: CIF (Common Intermediate Format) has 288 lines by 360 pixels/line of luminance information and 144 x 180 of chrominance information, QCIF (Quarter Common Intermediate Format), which is 144 lines by 180 pixels/line of luminance and 72 x 90 of chrominance. The choice of CIF or QCIF depends on available channel capacity, e.g., QCIF is normally used if p<3.

	The actual encoding algorithm is similar to (but incompatible with) that of MPEG. Another difference is that H.261 needs substantially less CPU power for real-time encoding than MPEG. The algorithm includes a mechanism that optimizes bandwidth usage by trading picture quality against motion, so that a quickly changing picture will have a lower quality than a relatively static picture. H.261 used in this way is thus a constant-bit-rate encoding.
Editor/Point-of-Contact:	ITU-T Study Group 15
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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WWW URL:	**http://www.itu.ch/**

ITU-T H.281

Standard:	A far end camera control protocol for videoconferences using H.224
Designation:	ITU-T H.281
Status:	ITU-T Recommendation
Publisher:	ITU-T
Date of Publication:	June 1995
Description:	ITU-T H.281 defines a far end camera control protocol for videoconferences using H.224.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.310

Standard:	High Res ATM
Designation:	ITU-T H.310
Status:	ITU-T Recommendation
Publisher:	ITU-T
Date of Publication:	Approval expected August 1996
Description:	This is a recommendation for VTC on ATM Networks up to 15 Mbps including MPEG-2 video, conversational terminal, and video-on-demand terminals.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+ 41 22 730 5554 + 41 22 730 5337 (fax)
E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.320

Standard:	Narrow Band Visual Telephone systems and terminal equipment
Designation:	ITU-T H.320
Status:	Recommendation, Formal
Publisher:	ITU-T
Date of Publication:	April 1994 (Revision 1)
Description:	Recommendation H.320 covers the technical requirements for narrow-band visual telephone services defined in H.200/AV.120-Series Recommendations, where channel rates do not exceed 1920 kbit/s. Note - It is anticipated that Recommendation H.320 will be extended to a number of Recommendations, each of which would cover a single video- conferencing or videophone service (narrow-band, broadband, etc.). However, large parts of these Recommendations would have identical wording, while in the points of divergence the actual choices between alternatives have not yet been made; for the time being, therefore, it is convenient to treat all the text in a single Recommendation. The service requirements for visual telephone services are presented in Recommendation H.200/AV.120-Series; video and audio coding systems and other technical set aspects common to audiovisual services are covered in other Recommendations in the H.200/AV.200-Series.
Editor/Point-of-Contact:	
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ITU-T H.321

Standard:	ATM Network VTC
Designation:	ITU-T H.321
Status:	ITU-T Recommendation, emerging
Publisher:	ITU-T
Date of Publication:	Approval expected November 1995
Description:	This standard is an adaptation of H.320 Terminal for ATM networks up to 2 Mbps.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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WWW URL:	**http://www.itu.ch/**

ITU-T H.322

Standard:	IsoEthernet LAN VTC
Designation:	ITU-T H.322
Status:	ITU-T Recommendation, emerging
Publisher:	ITU-T
Date of Publication:	Approval expected November 1995
Description:	This standard operates over Guaranteed Quality of Service Local Area Networks such as Iso-Ethernet up to 2 Mbps.
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Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.323

Standard:	Ethernet LAN VTC
Designation:	ITU-T H.323
Status:	ITU-T Recommendation, emerging
Publisher:	ITU-T
Date of Publication:	Approval expected August 1996
Description:	This standard operates over Non-Guaranteed Quality of Service Local Area Networks such as Ethernet, FDDI, Token Ring up to 2 Mbps.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.324

Standard:	Low Bitrate Videophone
Designation:	ITU-T H.324
Status:	ITU-T Recommendation, emerging
Publisher:	ITU-T
Date of Publication:	Approval expected November 1995
Description:	This standard operates over the existing analog telephone system up to 28.8 kbps.
Editor/Point-of-Contact:	
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+ 41 22 730 5554 + 41 22 730 5337 (fax)
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ITU-T H.324M

Standard:	Mobile Videophone
Designation:	ITU-T H.324M
Status:	ITU-T Recommendation, emerging
Publisher:	ITU-T
Date of Publication:	Approval expected August 1996
Description:	This standard operates over a mobile cellular telephone system up to 28.8 kbps.
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E-mail address:	**helpdesk@itu.ch**
WWW URL:	**http://www.itu.ch/**

ITU-T H.331

Standard:	Broadcasting type audiovisual multipoint systems and terminal equipment
Designation:	ITU-T H.331
Status:	ITU-T Recommendation
Publisher:	ITU-T
Date of Publication:	February 1994
Description:	ITU-T H.331 defines broadcasting type audiovisual multipoint systems and terminal equipment.
Editor/Point-of-Contact:	
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WWW URL:	**http://www.itu.ch/**

ITU-T T.120

Standard:	Multimedia Data Conferencing
Designation:	ITU-T T.120
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Decision expected February 1996
Description:	Multimedia Telecommunications involve the transport of information signals in a wide range of formats, efficiently, flexibly, and securely. Moreover, the communication protocol must not be confined to point-to-point operation between identical terminals but permit group working between many terminals which may be geographically dispersed and very diverse in their types. Such a protocol is defined in a series of ITU Recommendations collectively referred to as "the T.120 series". This recommendation contains a general description of the T.120 series recommendations showing the interrelationships between the constituent standards, and to the other standards for the systems in which the T.120 series is to be used.
Editor/Point-of-Contact:	Bruce DeGrasse
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E-mail address:	**73760.2250@compuserve.com**
WWW URL:	**http://www.csn.net/imtc/**

ITU-T T.121

Standard:	Generic Application Template (T.GAT)
Designation:	ITU-T T.121
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Decision expected February 1996
Description:	This Recommendation describes a generic model of a T.120 application and defines a Generic Application Template encompassing those operations that are common to most T.120 application protocols. It is intended to ease the task of the application protocol developer and to provide a common structure to standardize T.120 application protocols. The Generic Application Template is a conceptual model and does not impose rules on the structure of application software.
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ITU-T T.122

Standard:	Multipoint Communication Service for Audiographics Conferencing - Service Definition
Designation:	ITU-T T.122
Status:	ITU-T Recommendation, Formal
Publisher:	ITU-T
Date of Publication:	1993
Description:	The Multipoint Communication Service (MCS) is a generic service designed to support highly interactive multimedia conferencing applications. It supports full-duplex multipoint communication among an arbitrary number of connected application entities over a variety of networks as specified in Recommendation T.123.
Editor/Point-of-Contact:	ITU-T Study Group 8
Address:	International Telecommunication Union (ITU) General Secretariat - Sales Section Place des Nations CH-1211 Geneva 20 Switzerland
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WWW URL:	**http://www.itu.ch/**

ITU-T T.123

Standard:	Protocol Stacks for Audiographic and Audiovisual Teleconference Applications
Designation:	ITU-T T.123
Status:	ITU-T Recommendation, Formal
Publisher:	ITU-T
Date of Publication:	1994
Description:	This Recommendation, which defines common protocol stacks for terminals and multipoint control units (MCUs), specifies network aspects of the AGC protocol suites, in the form of profiles for each network identified. Each profile specifies a set of protocols which may extend to layer 7 of the OSI reference model, depending upon the mode selected. The rationale for this Recommendation is as follows: audiographic and video conferencing are intended to form part of the repertoire of ISDN services. Teleconferencing via ISDN involves the integration of multimedia (audio, video, an data) in a connection which may be the aggregate of a number of physical channels. The provision of these services is not, however, limited to the ISDN, and a range of other network scenarios is identified. For instance, CSDN may provide similar, though less flexible, service to that of the ISDN. In cases where the audio and video signals are provided separately, the data channel for control and enhancement of the teleconference may be provided via PSDN or PSTN.
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ITU-T T.124

Standard:	Generic Conference Control
Designation:	ITU-T T.124
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Resolution 1 approved March 1995
Description:	This Recommendation provides a high-level framework for conference management and control of audiographic and audiovisual terminals and multipoint control units (MCUs). It encompasses generic conference control (GCC) functions such as conference establishment and termination, managing the roster of nodes participating in a conference, managing the roster of Application Protocol Entities and Application Capabilities within a conference, registry services for use by Application Protocol Entities, co-ordination of conference conductorship, as well as other miscellaneous functions.
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ITU-T T.125

Standard:	Multipoint Communication Service Protocol Specification
Designation:	ITU-T T.125
Status:	ITU-T Recommendation, Formal
Publisher:	ITU-T
Date of Publication:	1994
Description:	This Recommendation defines a protocol operating through a hierarchy of a multipoint communication domain. It specifies the format for protocol messages and procedures governing their exchange over a set of transport connections. The purpose of the protocol is to implement the Multipoint Communication Service defined by ITU-T T.122.
Editor/Point-of-Contact:	ITU-T Study Group 8
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ITU-T T.126

Standard:	Multipoint Still Image and Annotation Protocol
Designation:	ITU-T T.126
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Resolution 1 approved March 1995
Description:	This Specification is a draft proposal for an application that supports shared whiteboarding and both soft and hard copy still image conferencing with associated annotations. It uses services provided by T.122 (MCS) and T.124 (GCC). Basic remote pointing and keyboard event exchanges have also been included such that terminals can implement basic computer application sharing. The details of communication with the input and output devices and the user interfaces on the host terminal are considered out of the scope of this Specification and are left to the discretion of the implementor. Therefore, this Specification makes no assumption that these I/O devices are of any specific architecture.
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ITU-T T.127

Standard:	Multipoint Binary File Transfer
Designation:	ITU-T T.127
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Resolution 1 approval March 1995
Description:	This Recommendation defines a protocol to support the interchange of binary files within an interactive conferencing or group working environment where the T.120 suite of standards is in use. It provides mechanisms which facilitate distribution and retrieval of one or more files simultaneously using the primitives provided by T.122 (Multipoint Communications Service). T.127 is designed to offer a versatile, light weight protocol which provides the core functionality to allow interworking between applications requiring a basic file transfer capability and also has flexibility to meet the demands of more sophisticated applications.
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ITU-T T.128

Standard:	Audio Visual Control for Multipoint Multimedia Systems
Designation:	ITU-T T.128
Status:	ITU-T Recommendation, Emerging
Publisher:	ITU-T
Date of Publication:	Determination February 1996
Description:	The Audio Visual Control application is the T.120 component that provides the framework for control and management of interactive Audio and Visual services within a multipoint multimedia communication environment. The Recommendation provides a toolkit of functions that can be used to provide management, routing, identification, and processing of Audio and Visual streams, together with remote device control and source selection.
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MPEG-1

Standard:	MPEG (Moving Pictures Expert Group) Coding of Moving Pictures and Associated Audio for Digital Storage Media Up to About 1,5 Mbit/s
Designation:	ISO/IEC 11172:1-5
Status:	Parts 1-4, IS status, Part 5 is DTR
Publisher:	ISO
Date of Publication:	ISO/IEC 11172-1:1993 ISO/IEC 11172-2:1993 ISO/IEC 11172-3:1993 ISO/IEC 11172-4:1995 ISO/IEC DTR 11172-5
Description:	MPEG (Moving Pictures Expert Group) is the name of the ISO committee that is working on digital color video and audio compression, and name of the standard they have produced. MPEG-1 is an open international standard for video compression that has been optimized for CD-ROM data transfer rates. MPEG-1 defines a bit-stream representation for synchronized digital video and audio, compressed to fit into a bandwidth of 1,5 Mbit/sec. This corresponds to the data retrieval speed from CD ROM, and DAT, a major application of MPEG for the storage of audio visual information on this media. MPEG is also gaining ground on the Internet as an interchange standard for video clips. The MPEG-1 standard is the five parts - systems, video encoding, audio encoding, compliance testing, and software simulation. The video stream takes about 1.15 Mbit/s, and the remaining bandwidth is used by the audio and system data streams.

The compressed data contains three types of frames: I (intra) frames are coded as still images; P (predicted) frames are deltas from the most recent past I or P frame; and B (bidirectional) frames are interpolations between I and P frames. I frames are sent once every 10 or 12 frames. Reconstructuring a B frame for display requires the preceding and following I and/or P frames, so these are sent out of time-order.

Substantial computing power is required to encode MPEG data in real time.

MPEG-2 is optimal for a variety of data rates ranging from three to 10 megabits per second and higher. It is expected to be used in the cable industry's planned 500 channel systems.

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WWW URL: **http://www.iso.ch/meme/JTC1SC29.html**

MPEG-2

Standard:	Generic Moving Picture Coding
Designation:	ISO/IEC 13818; Parts 1-7
Status:	DIS, Emerging
Publisher:	ISO
Date of Publication:	Under development; Part 3 reached IS status in 1995
Description:	MPEG-2 is optimal for a variety of data rates ranging from three to 10 megabits per second and higher. It consists of 7 parts: Part 1 - Systems (DIS) Part 2 - Video (DIS) Part 3 - Audio (ISO, 1995) Part 4 - Compliance Testing (DIS) Part 5 - Technical Report on Software (DTR) Part 6 - Systems Extensions Part 7 - Audio Extensions It is expected to be used in the cable industry's planned 500 channel systems.

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MPEG-4

Standard:	Very-low Bitrate Audio-Visual Coding
Designation:	MPEG-4
Status:	IS status not expected before November 1998
Publisher:	ISO
Date of Publication:	MPEG-4 Proposal Package Description (PPD) - Revision 2 (ISO/IEC JTC1/SC29/WG11 N0937, March 1995)
Description:	MPEG-4 is an emerging coding standard that supports new ways (notably content-based) for communication, access, and manipulation of digital audio-visual data. Recognizing the opportunities offered by low-cost, high-performance technology, and the challenge of rapidly expanding multimedia databases, MPEG-4 will offer a flexible framework and an open set of tools supporting a range of both novel and conventional functionalities. This approach will be particularly attractive because rapidly progressing technology will facilitate downloading of tools in a practical way. MPEG-4 is forseen to be composed of four elements: MPEG-4 Syntactic Description Language, Tools, Algorithms, and Profiles. Example applications include audio-visual database access, audio-visual communications and messaging, and remote monitoring and control.
Editor/Point-of-Contact:	ISO/IEC JTC1/SC29 WG 11
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PCS

Standard:	Personal Conferencing Specification (PCS)
Designation:	PCS, Version 1.0
Status:	Industry, Open
Publisher:	Personal Conferencing Work Group (PCWG)
Date of Publication:	1994
Description:	PCS defines a common, interoperable architecture for conferencing and communications in the PC environment. It was developed cooperatively by members of the PCWG which has broad membership from the telecommunications, conferencing and personal computer industries. PCS 1.0 defines interoperability requirements for ISDN/LAN Conferencing End Points and ISDN Multipoint Control Units. The next version will add ITU-T H.320 and ITU-T T.120 requirements as a means of sending a clear message of PCWG support of standards and interoperability. To facilitate the development and delivery of interoperable conferencing and communications products, PCWG will develop an Interoperability Specification and interoperability programs and testing. The PCS specification will evolve to align with those needs.
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E-mail address:	**info@insyncp.com**
WWW URL:	**http://www.gopcwg.org**

VTC001-Rev.1

Standard:	Industry Profile for Video Teleconferencing (VTC)
Designation:	VTC001-Rev.1
Status:	Industry standard
Publisher:	Corporation for Open Systems International
Date of Publication:	25 April 1995
Description:	The purpose of this Profile is to provide a standards-based reference document for users as an aid in defining their procurement specifications for video teleconferencing equipment, and for vendors as a guide to understand what features and functionality users may request. It is not possible, not is it practical, to make assumptions regarding the environments in which video teleconferencing will occur. Therefore, this Profile was developed to allow video teleconferences to take place regardless of which system is in use at either location. It is based on the ITU-T H.320 series of Recommendations. Revision 1 adds the multipoint features and functionality of H.321. ANSI video teleconferencing standards will be referenced upon their ratification. Annex B contains additional DoD information and optional specifications. The Profile replaces MIL-STD-188-331 and 188-331A, Interoperability and Performance Standard for VTC. Moreover, the international standards cited in the Profile are fully interoperable with the federal standard for VTC, FIPS 178.
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APPENDIX A.8

MULTIMEDIA SCRIPTING

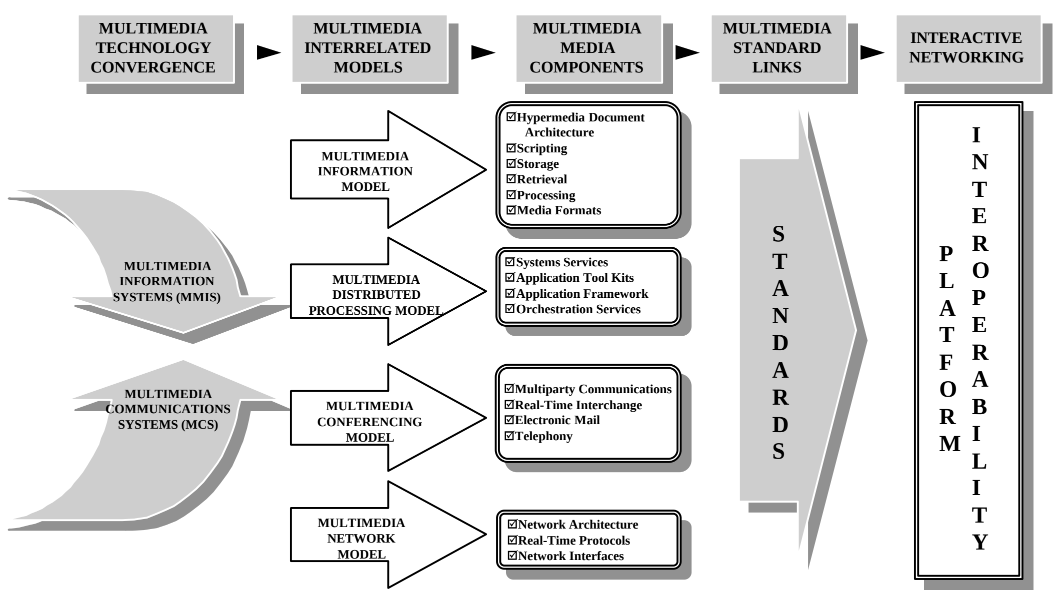
A.8 MULTIMEDIA SCRIPTING

IMPACT OF STANDARDS ON THE USE OF MULTIMEDIA SCRIPTING

A number of multimedia scripting languages have been developed. ScriptX, Gain Extension, and QuickTime are vendor standards for multimedia data; HyTime is an international standard for hypermedia documents. SMDL (Standard Music Description Language) is a HyTime application. SMSL (Standard Multimedia Scripting Language) is an open scripting environment primarily targeted toward SGML/HyTime applications.

Some languages are limited to a specific hardware platform. When choosing a scripting language, be aware of the capabilities for playback at the receive sites. When base platforms are dissimilar, or do not have the appropriate boards or chips, a nonplatform-specific development language must be determined.

There are two types of scripting languages: (1) higher-level languages designed for cross-platform development that are also playback languages and (2) languages used within a product to support development applications. Developing one common language would solve the interoperability issue. Figure IV shows this dependency.



OEM Magazine, February 1994

Figure IV. Common Scripting Language is Needed for a Universal Authoring Environment

One example of a language used to support development applications is GEL, part of the Gain Momentum product line. GEL is an English-like, high-level scripting language that helps to rapidly develop complex applications. Other products contain similar languages: Authorware scripting language, IconAuthor scripting language, and Kaleida's ScriptX.

The functionality and complexity of scripting languages vary from scripted interactions and media playback to scripted network interface and Graphical User Interface (GUI). To provide comprehensive scripting capability, one multimedia language must support many graphic formats, various audio and video compression and decompression formats, one or more of the formats for characters and document characteristics, and be usable across electronic networks.

HyTime was designed by the traditional publishing industry. It is a multimedia extension to Standard Generalized Markup Language (SGML), a document description language to which HyTime adds new elements: graphics, audio, and video. The HyTime standard specifies how concepts common to all hypermedia documents can be represented using SGML.

Documents created using this standard are interoperable. HyTime software can browse, render, format, and query compliant documents regardless of whether or not the software can understand or render the multimedia objects.

The Standard Music Description Language, SMDL, a Hytime and SGML application, defines a language for the representation of music information, either alone, or in conjunction with text, graphics, or other information needed for publishing or business purposes. Multimedia time sequencing information is also supported.

GEL

Standard:	Gain Extension Language
Designation:	GEL
Status:	Vendor, Informal
Publisher:	Gain Technology Corporation (A Sybase Company)
Date of Publication:	1992
Description:	GEL is the scripting language of the Gain Momentum application development environment. GEL is an English-like, high-level scripting language that helps to rapidly develop network based multimedia applications using a shared database. GEL provides substantial reduction in lines-of-code over traditional 3GL languages for faster delivery of applications. GEL's interactive scripting environment permits instant testing of applications-- no time-consuming compile-link-debug cycle is required. GEL also allows menu-selectable templates of sample GEL functions, statements, and messages; a full suite of interactive debugging tools; and also supports setting breakpoints; single-stepping; and interactive setting of variables, handler tracing. Current product thrust into multimedia is centered around its new object-oriented Momentum tools family of three integrated products. (1) *Build Momemtum* is a front-end graphical application development tool, (2) *Gain Momemtum* provides an environment for integrated access to relational databases for multimedia information delivery; (3) *Enterprise Momemtum* is a repository-based new multimedia development environment for building complex,

enterprisewide applications based on an active repository.

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HYTIME

Standard:	Hypermedia/Time Based Structuring Language (HyTime)
Designation:	ISO/IEC 10744
Status:	IS, Formal
Publisher:	ISO/IEC
Date of Publication:	August 1992
Description:	HyTime defines a language and underlying model for the representation of hyperdocuments that link and synchronize static and time-based information contained in multiple conventional and multimedia documents and information objects.

HyTime is an SGML application. It can be used to represent documents at any stage of processing from revisable to "optimized for interactive access," although many applications will choose a more optimized representation in the latter case.

The HyTime standard specifies how certain concepts common to all hypermedia documents can be represented using SGML. These concepts include association of objects within documents with hyperlinks; placement and interrelation of objects in space and time; logical structure of the document; and inclusion of nontextual data in the document.

An "object" in HyTime is part of a document and is unrestricted in form; it may be video, audio, text, a program, graphics, etc.

SGML (Standard Generalized Markup Language: ISO 8879) is a metalanguage used to specify document markup schemes called Document Type Definitions (DTDs). HyTime is not itself a DTD, but provides constructs and guidelines for making DTDs for describing Hypermedia documents. For instance, the Standard Music Description Language (SMDL: ISO/IEC Committee Draft 10743) defines a DTD that is an application of HyTime.

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OMFI

Standard:	OMFI (Open Media Framework Interchange)
Designation:	
Status:	Vendor
Publisher:	Avid Technology
Date of Publication:	1993
Description:	An industry effort led by Avid Technology, the OMFI format contains composition data needed to play or re-edit the media presentation. OMFI is among the technologies included in the IMA's Draft Recommended Practice for Multimedia Data Exchange, dated 23 May 1995.
Editor/Point-of-Contact:	Avid Technology, Inc.
Address:	Metropolitan Technology Park One Park West Tewksbury, MA 01876
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QUICKTIME

Standard: QuickTime

Designation:

Status: Vendor, Informal

Publisher: Apple Computer

Date of Publication:

Description: QuickTime is a system-level manager of dynamic data types, hardware peripherals, and compression algorithms. It features voice integration into documents and sound, video, and animation integrated into computer help systems.

A QuickTime movie contains time-based data that may represent sound, video, or other time-sequenced information such as financial data or lab results. A movie is constructed of one or more tracks, each track being a single data system.

A QuickTime movie file on an Apple Macintosh consists of a "resource fork" containing the movie resources and a "data fork" containing the actual movie data or references to external data sources such as video tape. To help systems that use single fork files exchange data, these can be combined into a file that uses only the data fork.

Movie resources are built up from basic units called atoms, which describe the format, size, and content of the movie storage element. Atoms can be nested within "container" atoms, which may themselves contain another container atom.

	The QuickTime Movie File is a published file format for storing multimedia content for QuickTime presentation. There are many atom types that define a wide variety of features and functions, including a TEXT media atom that allows displayed text to change with time, and user-defined data atoms called "derived media types." These allow for the custom handling of data by overriding the media handler with a user-supplied driver.
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WWW URL:	**http://www.apple.com**

SCRIPTX

Standard:	ScriptX
Designation:	
Status:	Vendor, Informal
Publisher:	Kaleida Labs
Date of Publication:	March 1993
Description:	ScriptX is a device-independent, object-oriented multimedia language that describes an application's structure, temporal data, events, and user interface, allowing developers to write a uniform set of APIs independent of specific hardware. ScriptX is designed to support applications on general-purpose desktop computers, workstations, personal digital assistants, and network services. Potentially ScriptX may be used in TV settop box interfaces.
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SMDL

Standard:	Standard Music Description Language (SMDL)
Designation:	ISO/IEC CD 10743
Status:	DIS ballot expected August 1995
Publisher:	ISO/IEC
Date of Publication:	1991
Description:	This standard defines a language for the representation of music information, either alone, or in conjunction with text, graphics, or other information needed for publishing or business purposes. Multimedia time sequencing information is also supported. SMDL is a HyTime application conforming to ISO/IEC 10744, Hypermedia/Time-based Structuring Language. SMDL is an SGML application conforming to ISO 8879, Standard Generalized Markup Language (SGML).
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SMSL

Standard:	Standard Multimedia Scripting Language (SMSL)
Designation:	SMSL
Status:	proposed standard
Publisher:	ISO/IEC JTC1 SC18/WG8; ANSI X3V1
Date of Publication:	tbd
Description:	The Standard Multimedia Scripting language (SMSL) is an open scripting environment primarily targeted toward SGML/HyTime applications. SMSL does not describe a single standardized scripting language, rather it describes the interfaces required to bring new and existing languages into the SGML/HyTime arena. A draft proposal was presented at the ISO/IEC JTC1 SC18/WG8 meeting in February 1995. Refinement of the draft proposal will be carried out by a Task Group of the ANSI X3V1 committee.
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APPENDIX A.9

TEXT

A.9 TEXT

IMPACT OF STANDARDS ON USE OF TEXT AND HYPERTEXT

INTRODUCTION: The impact of standards on the use of text and hypertext is significant when planning to use multimedia titles in any project. These issues are addressed in the following subsections.

ASCII is a bit-mapped character set standard for interchange of text encoded with 7-bits in an 8-bit octet. There is an international version of ASCII, the 7-Bit Coded Character Set for Information Exchange. The Universal Multiple Octet Coded Character Set provides multiple octets for coding the less frequently used characters and supports all the world's major languages. Another standard specifies methods of extending the limits of 7-bit and 8-bit character sets coded by single octets. The ASCII standard is inadequate for work that is international or uses languages other than English.

In addition to the characters themselves, documents have encoded format symbols. When a document file is exported as an ASCII or other type file, some of this information, such as indentions is lost. Several standards have been developed that retain and encode the presentation information and the text character data.

PostScript depicts the output of a final form of the page for the logical structure of a document: outputs complete, formatted, and in final-form page images. SPDL clear text encoding is based on PostScript and includes binary encodings.

SGML and SPDL are formal international standards. RTF and PostScript are vendor standards and are not interoperable with other systems. The software products in use and whether the computer is stand-alone or part of a network will determine which standard to use.

A number of standards provide a definition of the document, how it is organized, how it is written, how it is transmitted, and how it is presented to the end user. For example, the PDF one-document description standard, is based on the PostScript page description language. PDF retains the original page design along with the data. Files transmitted in PDF can be accessed in their original form by different systems.

PDF is important because it retains the original page design along with the data. The design elements, such as indentations and text highlights, that contribute to readability and usability of a document are usually lost in electronic communications, for example, when a word processing document is exported as an ASCII file. An ASCII file has a high level of interoperability, but much time must be spent reformatting documents after they are retrieved.

If a manual or workbook has loose-leaf publishing requirements, formatting becomes a critical requirement. The specific composition rules for adding change information to a technical manual and the ability to create change pages and change packages would be lost if converted to an ASCII file. In addition, regulations, technical manuals, training manuals, and other technical documents are not easily converted into ASCII because they involve charts and graphs. A format other than ASCII is needed to include the graphic elements.

Another valuable document form is hypermedia. Hypermedia documents may contain any data type that can be represented as bits. These data can be linked, or may contain links, to other data, including noncharacter data. However, noncharacter data cannot be converted to ASCII files.

ITU-T T.434, Binary File Transfer (BFT) enables the actual documents or files themselves to be sent via modem, instead of just their images. The Recommendation is based on Delrina's BFT technology in its Fax-a-File Winfax Pro software for PCS.

7-Bit ASCII

Standard:	Coded Character Sets - 7-Bit: American National Standard Code for Information Interchange (7-Bit ASCII)
Designation:	FIPS: 1-2, 1984; X3.4-1986 (R1992); ISO 646:1991
Status:	FIPS; Government; ANSI; ISO
Publisher:	NIST; ANSI; ISO
Date of Publication:	1984; 1986; 1991
Description:	This is the basic character set standard for interchange of text encoded with 7-bits in an 8-bit octet.
Editor/Point-of-Contact:	
Address:	ANSI 11 West 42nd St. New York, NY 10036
Telephone/Fax:	212-642-4900 212-302-1286 (fax)
E-mail address:	**info@ansi.org**
WWW URL:	**http://www.ansi.org/home.html**

8-Bit ASCII

Standard:	8-Bit Single-Byte Coded Graphic Character Sets, Part 1: Latin Alphabet
Designation:	ISO 8859-1:1987; ANSI/ISO 8859-1:1992
Status:	FIPS; Government; ANSI; ISO
Publisher:	ANSI; ISO
Date of Publication:	1987 (ISO); 1992 (ANSI)
Description:	Part 1 of this standard defines a coded character set for 191 graphic characters used in Western European languages, including English. It also reserves 65 code positions for control characters. The graphic characters of 7-bit ASCII (X3.4, 1986) is a proper subset and forms the left or lower-half of the code table.
Editor/Point-of-Contact:	
Address:	ANSI 11 West 42nd St. New York, NY 10036
Telephone/Fax:	212-642-4900 212-302-1286 (fax)
E-mail address:	**info@ansi.org**
WWW URL:	**http://www.ansi.org/home.html**

BFT

Standard:	Binary File Transfer (BFT) Format for the Telematic Services
Designation:	ITU-T T.434, BFT
Status:	ITU-T Recommendation
Publisher:	ITU
Date of Publication:	1994
Description:	BFT refers to a new way of transferring files between fax modems. Instead of sending or receiving just an image (TIFF) of a document, BFT enables the actual documents or files themselves to be sent. At present, the only company using this format is Delrina in its Winfax Pro software for PCS. Fax-a-File is Delrina's BFT technology. However, according to Delrina, since the BFT format has been adopted by ITU, Microsoft has decided to incorporate BFT in the fax viewer software it will embed in it Chicago version of Windows. Microsoft will also incorporate into its fax software a generic text interpreter like Adobe Acrobat, which will be capable of accepting any word processing format.
Editor/Point-of-Contact:	
Address:	Delrina (Canada) Corporation 895 Don Mills Road 500-2 Park Centre Toronto, Ontario Canada M3C 1W3
Telephone/Fax:	416-441-3676 416-441-0333 (fax)
E-mail address:	
WWW URL:	**http://www.delrina.com**

DSSSL

Standard:	DSSSL (Documentation Style Semantics and Specifications Language)
Designation:	ISO/IEC 10179
Status:	DIS, Formal
Publisher:	ISO/IEC
Date of Publication:	Expected July/August 1995
Description:	A multipart standard describing how SGML can be used to associate structural information with a document that describes the presentation style intended by its author. It is being developed by ISO/IEC JTC1/SC18. DSSSL's presentation style can be applied to an SGML document. Also, DSSSL uses a subset of the Scheure Scripting language. The DSSSL Standard addresses the fundamental principle of radically separating content and appearance. The objective of DSSSL is to provide formal means for presenting all types of document production specifications, including high-quality typography. With DSSSL, formatting specifications can be interchanged with SGML documents while still preserving the essential distinction between form and content (the text itself).

DSSSL can associate formatting descriptions with individual SGML elements as defined in the document- type definition (DTD) as well as combinations of elements, elements with user-specifiable relationships to other elements, and particular sequences or components of the SGML document content. In addition, DSSSL enables formatting information to be associated with any combination of the above. This layered approach becomes a powerful tool in the control of document format and appearance across operating systems and architectures. DSSSL language conventions can standardize screen display, as well as produce printed matter in a different style or format from the screen display from the same document. DSSSL also includes the capability to translate into an existing processing language such as SQL or a traditional text formatting language.

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401-421-9551 (fax)

E-mail address:

EUC

Standard:	Character Code Structure and Extension Techniques
Designation:	ISO 2022:1994
Status:	IS; Formal
Publisher:	ISO
Date of Publication:	1994
Description:	Specifies methods of extending the 255 glyph limit of character sets coded by single octets. The code extension techniques permit subcollections to be loaded on top of the basic collection and then used before returning the basic collection to its normal place in the code.
Editor/Point-of-Contact:	Edwin Hart
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FONT INFORMATION EXCHANGE

Standard:	Font Information Exchange Parts 1-7
Designation:	ISO/IEC 9541:1991
Status:	Parts 1-3 IS, Formal; Parts 4-6 DIS; Part 7, CD
Publisher:	ISO
Date of Publication:	Parts 1-2, 1991; Part 3, 1994
Description:	This standard specifies formats for the interchange of fonts. A font is characterized by many parameters (e.g., glyph set, character widths, rules for kerning). Part 1 is the Architecture, Part 2 the Interchange Format, and part 3 the Glyph Shape Representation. This standard is under development by ISO/IEC JTC1/SC18.
Editor/Point-of-Contact:	Edwin Smura
Address:	Xerox Corporation 791 S. Aviation Ave. ESAB-364 El Segundo, CA 90245
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WWW URL:	

HTML

Standard:	HyperText Markup Language, an SGML-based markup language.
Designation:	HTML 2.0
Status:	Informal
Publisher:	Internet/WWW
Date of Publication:	1994; HTML 3.0 forthcoming in late 1995
Description:	HTML consists of a set of tags that conform to SGML rules and conventions. The HTML tag set can be used as the basis to define a DTD (Data-Type Definition) (an HTML DTD) that is consistent with SGML syntax. By defining HTML in an SGML DTD, HTML becomes an SGML application.

The HTML document type contains relatively general semantics for representing information for linking of data and document with a limited SGML tag set and limited formatted capability. Moreover, simplicity was the guide in development so that multiple browsers and editors could be used on multiple platforms. The following list gives some idea of the specific uses available: hypertext news, mail, on-line documentation, menus of options, database query results, and simply structured documents with in-line graphics. HTML has the capability to allow networked hypertext to use text, sound, movie, and images in a variety of formats.

Future: The HTML Document Type Definition (DTD) is being modified to incorporate more complex text structures in the future. HTML is also developing a more robust style sheet capability. Also, endeavors include the development of HTML+, a derivative HTML that is beginning to appear in Mosaic and other WWW client programs. A major advantage is that the query forms in HTML+ will allow many SGML searching operators to be included in WWW clients.

Editor/Point-of-Contact: Tim Berners-Lee (Chairman HTML Working Group) or Daniel W. Connolly (Editor of HTML 2.0 Specification)

Address:

Telephone/Fax:

E-mail address: **timbl@www3.cern.ch** **connolly@hal.com**

WWW URL: **http://www.w3/org/hypertext/www/markup/html3-dtd.txt**

ISO/IEC 10646-1

Standard:	Universal Multiple-Octet Code Character Set (UCS), Part 1: Architecture and Basic Multilingual Plane
Designation:	ISO/IEC 10646-1; UCS
Status:	IS; Formal
Publisher:	ISO
Date of Publication:	1993
Description:	This standard is applicable to the representation, transmission, interchange, processing, storage, input and presentation of the written form of the languages of the world as well as additional symbols. The long-term goal for ISO/IEC 10646 is to encode every code used in the world. It is a multi-lingual, multi-byte coded character set. The standard uses either a 16-bit (UCS-2) or a 32-bit (UCS-4) character encoding. Unicode, Inc. is a consortium dedicated to implementing the Unicode Standard, which is a subset of 10646.
Editor/Point-of-Contact:	
Address:	Unicode, Inc. P.O. Box 700519 San Jose, CA 95170-0519
Telephone/Fax:	408-777-5870 408-777-5082 (fax)
E-mail address:	**unicode-inc@unicode.org**
WWW URL:	**http://www.stonehand.com/unicode.html**

MIL-STD-1840B

Standard:	Automated Interchange of Technical Information
Designation:	MIL-STD 1840B
Status:	Military standard
Publisher:	DoD
Date of Publication:	1987; Revised 3 November 1992
Description:	The purpose of this standard is to standardize the formats for exchange of digital information between organizations or systems exchanging digital forms of technical information necessary for the development and logistic support of defense systems throughout their lifecycle. The initial areas addressed by this standard involved the interface with computer technologies which are automating the creation, storage, retrieval, and delivery of hard copy forms of technical manuals and engineering drawings. This revision of the standard also addresses electronic product data, new packaging of data for electronic trade business transactions, and electronic product data.
Editor/Point-of-Contact:	
Address:	DODSSP Standardization Document Order Desk 700 Robbins Avenue Building 4D Philadelphia, Pennsylvania 19111-5094
Telephone/Fax:	215-697-2569
E-mail address:	
WWW URL:	

PDF

Standard:	Portable Document Format (PDF)
Designation:	PDF, Version 1.1
Status:	Vendor
Publisher:	Adobe Systems, Inc.
Date of Publication:	
Description:	PDF is the file format underlying Adobe's Acrobat family of software. Version 1.1 of PDF is now finalized and is used in Acrobat Version 2.0 products. It allows documents consisting of "printed" pages to be distributed and viewed electronically.
Editor/Point-of-Contact:	
Address:	Adobe Systems Inc. 1585 Charleston Rd. Mountain View, CA 94039-7900.
Telephone/Fax:	415-961-4400 415-961-3769 (fax)
E-mail address:	
WWW URL:	**http://www.adobe.com**

POSTSCRIPT

Standard:	PostScript
Designation:	
Status:	Vendor, Informal
Publisher:	Adobe Systems
Date of Publication:	1986
Description:	PostScript is a page description language designed for presentation of complete, formatted, final-form page images on output printing devices. It heavily influenced the ISO/IEC standard 10180, Standardized Page Description Language.
Editor/Point-of-Contact:	Adobe Systems Inc.
Address:	1585 Charleston Rd. Mountain View, CA 94039-7900
Telephone/Fax:	415-961-4400 415-961-3769 (fax)
E-mail address:	
WWW URL:	**http://www.adobe.com**

RTF

Standard: Rich Text Format (RTF) Specification
Designation: RTF, S13564
Status: Vendor, Informal
Publisher: Microsoft
Date of Publication: January 1995
Description: RTF text is a form of encoding various text formatting properties, document structures, and document properties using the printable ASCII character set. Special characters can be also thus encoded, although RTF does not prevent the use of character codes outside the ASCII printable set.

The main encoding mechanism of "control words" provides a name space that may be later used to expand the realm of RTF with macros, programming, etc.

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206-883-8101 (fax)
E-mail address:
WWW URL: **http://www.microsoft.com**

SGML

Standard:	SGML (Standard Generalized Markup Language)
Designation:	ISO/IEC 8879; FIPS 152; MIL-M-28001B
Status:	IS; Formal; U.S. Government
Publisher:	ISO/IEC; DoD
Date of Publication:	1986; Amendment 1: 1988; 1993 (MIL-M)
Description:	SGML is a meta-language that allows users to define, in machine-readable form, the structure and content of any class of documents. The standard specifies a method for creating document hierarchy models in which every element in a document fits into a logical, predictable structure. SGML is able to separate the logical and physical structure of text. In this way, the standard is able to distinguish between the role of piece of text (e.g., caption, title, chapter, index) and its appearance (e.g., type face, font size, margin). This permits text to be tagged with descriptive markup, enhancing its functionality. By providing the ability to associate processing instructions with document markup, SGML includes a mechanism for referencing nontext forms within a text document. By providing tags that enable query and hypertext capabilities, SGML is a standard that allows the production of intelligent documents for distribution and use on CD-ROM and other random access media. The SGML standard is particularly beneficial to organizations that exchange information between systems, applications, departments, and users.
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Saratoga CA 95070

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408-867-1805 (fax)
E-mail address: **goldfarb@interramp.com**
WWW URL:

SPDL

Standard:	SPDL (Standard Page Description Language)
Designation:	ISO/IEC10180:1992
Status:	IS; Formal
Publisher:	ISO
Date of Publication:	1995
Description:	This standard defines a language for the specification of electronic documents, composed of bitonal, gray scale, or full-color text, images and geometric graphics, in a form suitable for presentation (i.e., printing or display on other suitable media). SPDL has both clear text and binary encodings. The clear text encoding is based on the PostScript page description language defined by Adobe Systems.
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E-mail address:	**Strassen.ESAE@xerox.com** **ftp://infosvrl.ctd.ornl.gov/pub/sgml/WG8/SPDL/**
WWW URL:	

APPENDIX A.10

OPTICAL MEDIA

A.10 OPTICAL MEDIA

IMPACT OF STANDARDS ON THE USE OF OPTICAL MEDIA

ISO 9660 (High Sierra) standardizes the logical (data storage) format and ISO 10149 (Yellow Book) the physical format of CD-ROM, but user interfaces, application platform support, and the utility of the information provided is driven by many different producers of CD-ROMs. Ultimately, end users have to deal with CD-ROM products containing different access/retrieval capabilities.

The Orange Book is an informal vendor standard by Apple for Compact Disk-Write Once (CD-WO). ECMA 168 (to be ISO/IEC 13490) expands upon the ISO 9660 standard and provides full Orange Book functionality including multisession recording, track-at-once recording, and packet recording. When used with an Orange Book writer, this will allow write-once CD to be used more like a general-purpose storage peripheral than is possible using ISO 9660.

ISO 9660, the international standard describing the logical layout for a compact disk (CD) initially developed by the High Sierra Group, is widely accepted. By using a standard layout, it allows information to be read by another system than the one that created the files. ISO 9660 describes logical sectors, blocks, fixed and variable length records, character encoding, and other data structures.

For example, although NIST has established a 5-1/4-inch standard for CD-ROMs, data from a 12-inch CD-ROM can be compatible with data from a 5-1/4-inch disk once accessed. Different military services are using different size disks, but as the data standard is the same, information is compatible across services. The logic layout is the same and the speed is the same (all the systems scan at 300 dots per inch).

The 5-1/4-inch disks are interchangeable and available from many vendors. The total cost is about the same, for either size disk. Data exchange is electronic, although not through disk transfer. Therefore, when disk logic is the same, disk size is not a compatibility issue.

There are similar standards for describing forms and databases: Forms Interface Management System (FIMS) and Structured Query Language

(SQL). The standardized data descriptors and access language provided can be used with a variety of different applications (products).

When selecting a digital data storage medium, the processing speed can be an important factor. Different CD formats can support a variety of audio and video rates. Table VII shows a comparison of CD formats.

The DoD-HDBK-CD handbook will provide guidance to Department of Defense agencies on the use of Compact Disc (CD) technology as the recommended method for physical distribution of information within DOD.

Table VII. A Comparison of CD Formats

MPEG ON CD					
MPEG Option	**ISO 9660**	**ISO 9660 XA**	**CD-1 FMV Phillips**	**CD-Digital Video Phillips**	**Video CD Nimbus**
Specification Book	Yellow Book	Yellow Book	Green Book	White Book	Red Book
CD Mode & Form	Mode 1 Form 1	Mode 2 Fpr, 1,2	Mode 2 Form 1,2	Mode 2 Form 2	CD-DA
Video Rate	Variable	Variable	1.18 Mbit/s	1.1519 Mbit/s	1.2 Mbit/s
Audio Rate	Variable	Variable	192 Kbit/s	224 Kbit.s	192 Kbit/s

CD-ROM Professional, July/August 1994

Note: MPEG Video and Audio Rates Specifications Vary Depending on the Target CD Format.

ANSI X3.191

Standard:	Recorded Optical Media Unit for Digital Information Interchange - 130 mm Write-Once Sampled Servo RZ Selectable-Pitch Optical Disk Cartridge
Designation:	ANSI X3.191:1991
Status:	ANSI standard
Publisher:	ANSI
Date of Publication:	1991
Description:	At 650 MB per side, the cartridge dimensions of this standard are different from those of other 130 mm WORM standards.
Editor/Point-of-Contact:	
Address:	ANSI 11 West 42nd St. New York, NY 10036
Telephone/Fax:	212-642-4900 212-302-1286 (fax)
E-mail address:	
WWW URL:	**http://www.ansi.org/docs/home.html**

CD-WO

Standard:	CD-WO (Compact Disc-Write Once)
Designation:	Orange Book
Status:	Vendor, Informal
Publisher:	Apple
Date of Publication:	1993
Description:	Developed by Apple Computer, the write-once specification is known as the Orange Book. Using write-once devices along with a supply of discs, users are able to produce discs in many different formats and avoid the expensive mastering and stamping process. It is compatible with the Red Book specifications, but its formats allow both audio and data recording.
Editor/Point-of-Contact:	Rita Brennan
Address:	Apple Computer, Inc. 20525 Mariani Avenue Cupertino, CA 95014
Telephone/Fax:	408-996-1010 408-974-0866 (fax)
E-mail address:	
WWW URL:	**http://www.apple.com**

DoD-HDBK-CD ROM

Standard:	CD-ROM Requirements and Guidelines
Designation:	DoD-HDBK-CD ROM
Status:	Draft
Publisher:	DoD
Date of Publication:	tbd
Description:	The purpose of this handbook is to provide guidance to Department of Defense agencies on the use of Compact Disc (CD) technology as the recommended method for physical distribution of information within DOD. ISO 9660 standardizes the logical (data storage) format and ISO 10149 the physical format of CD-ROM, but user interfaces, application platform support, and the utility of the information provided is driven by many different producers of CD-ROMs. Ultimately, end users must deal with CD-ROM products containing different access/retrieval capabilities. Objectives are to encourage a common migration path to CD-ROM; compile adopted standards for the use of CD-ROM; provide guidance to CD-ROM producers/users; establish a DoD form for discussions of CD-ROM issues/ standards, their use by DoD publishers, their impact on DoD end users, and their impact/use in the CD-ROM industry as a whole; and provide a central DoD library/catalog of CD-ROM titles and their contents for DoD components/activities.
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WWW URL: **http://www.itsi.disa.mil:5580/T3040**

ECMA 168

Standard: Volume and file structure of read-only and write-once compact disc media for information interchange

Designation: ECMA 168; ISO/IEC DIS 13490

Status: ECMA Standard; DIS

Publisher: ECMA; ISO/IEC

Date of Publication: June 1992 (ECMA); DIS 13490, was expected to complete the balloting process at the end of August 1993.

Description: ECMA 168 (ISO/IEC DIS 13490) expands upon the ISO 9660 CD-ROM standard and provides for full Orange Book functionality, including multisession recording, track-at-once recording, and packet recording. When used with an Orange Book writer, this will allow write-once CD to be used more like a general-purpose storage peripheral than is possible using ISO 9660. ECMA 168 also incorporates the functionality of Rock Ridge: the ability to use UNIX-style filenames, UNIX permissions, and deep directory hierarchies. Much thought was put into character set issues, and ECMA 168 accommodates multiple-byte character sets such as ISO 10646. Although ECMA 168 is not upward-compatible with ISO 9660, it is possible to write a "conformant disc" containing both sets of volume and file structures. If such a disc is Yellow Book compatible (a CD-ROM or a written disc-at-once), it could be read on either an ISO 9660 system or an ECMA 168 system. There are many common elements between ECMA 168 and ECMA 167, which is a new standard intended primarily for WORM (Write Once Read Multiple) and erasable optical disks. Hopefully this will encourage developers to support both standards. Currently, there are not any companies which support ECMA 168 in their products.

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+41-22-733-3430 (fax)
E-mail address: **central@isocs.iso.ch**
WWW URL: **http://www.iso.ch/welcome.html**

FIMS

Standard: FIMS (Form Interface Management System)
Designation: ISO/IEC 11730: 1994
Status: ISO; Formal
Publisher: ISO/IEC
Date of Publication: 1994
Description: FIMS is a software specification for describing human interfaces based on forms, including the description of displays, dialog management, and interactions with application programs.
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WWW URL: **http://www.iso.ch/welcome.html**

ISO/IEC 9171

Standard:	130 mm Optical Disk Cartridge, Write Once, for Information Interchange - Part 1: Unrecorded Optical Disk Cartridge, Part 2: Recording Format
Designation:	ISO/IEC 9171, Parts 1-2; ANSI X3.211; ANSI X3.214
Status:	ISO/IEC
Publisher:	IS; ANSI standard
Date of Publication:	1990
Description:	The standard addresses two formats: Format A, Continuous Composite (CC) and Format B, Samples Servo (SS), are both 325 MB per side but incompatible with each other. Format A is the ISO/IEC version of ANSI X3.211 while format B is the ISO/IEC version of ANSI X3.214.
Editor/Point-of-Contact:	
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WWW URL:	**http://www.iso.ch/welcome.html**

ISO/IEC 10089

Standard:	130 mm Rewritable Optical Disk Cartridge for Information Interchange, Format A - Continuous Composite (CC) and Format B - Sampled Servo (SS)
Designation:	ISO/IEC 10089:1991; ANSI X3.212
Status:	IS; ANSI Standard
Publisher:	ISO/IEC; ANSI
Date of Publication:	1991
Description:	Both formats are 325 MB per side, but Format A is incompatible with Format B. Format A is the ISO/IEC version of ANSI X3.212.
Editor/Point-of-Contact:	
Address:	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+41-22-749-0111 +41-22-733-3430 (fax)
E-mail address:	**central@isocs.iso.ch**
WWW URL:	**http://www.iso.ch/welcome.html**

ISO/IEC 10090

Standard:	90 mm Optical Disk Cartridges Rewritable and Read Only, for Data Interchange
Designation:	ISO/IEC 10090:1992
Status:	IS
Publisher:	ISO/IEC
Date of Publication:	1992
Description:	These are 128 MB per side.
Editor/Point-of-Contact:	
Address:	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+41-22-749-0111 +41-22-733-3430 (fax)
E-mail address:	**central@isocs.iso.ch**
WWW URL:	**http://www.iso.ch/welcome.html**

ISO/IEC 10149

Standard:	Data Interchange on Read-Only 120 mm Optical Data Disks (CD-ROM)
Designation:	ISO/IEC 10149; Yellow Book, CD-ROM
Status:	IS, Formal
Publisher:	ISO
Date of Publication:	1989
Description:	This specification,known as the Yellow Book, was originally developed by Sony and Phillips. It is used to store digital information other than music on compact discs. It standardizes the physical characteristics (track shape, track pitch, and data structure) of a CD. It consists of two modes: mode 1 is for computer data and mode 2 is for compressed audio data and video/picture data. When a disc conforms to this standard, it will usually say "data storage" beneath the "disc" logo. CD-ROM/XA is an extension of this standard.
Editor/Point-of-Contact:	
Address:	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+41-22-749-0111 +41-22-733-3430 (fax)
E-mail address:	**central@isocs.iso.ch**
WWW URL:	**http://www.iso.ch/welcome.html**

<u>**ISO/IEC 10855**</u>

Standard:	365 mm Optical Disk Cartridge for Information Interchange - Write Once
Designation:	ISO/IEC 10855:1993; ANSI X3.200:1992
Status:	IS; ANSI Standard
Publisher:	ISO/IEC; ANSI
Date of Publication:	1992 (ANSI); 1993 (ISO)
Description:	At 3.4 GB per side, this standard is the ISO/IEC version of ANSI X3.200:1992.
Editor/Point-of-Contact:	
Address:	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20 Switzerland
Telephone/Fax:	+41-22-749-0111 +41-22-733-3430 (fax)
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ISO/IEC 11560

Standard:	Information Interchange on 130 mm Optical Disk Cartridges of the Write Once, Read Multiple (WORM) Type, Using the Magneto-Optical Effect
Designation:	ISO/IEC 11560:1993; ANSI X3.220
Status:	IS; ANSI Standard
Publisher:	ISO/IEC; ANSI
Date of Publication:	1992
Description:	At 325 MB per side, this standard is the ISO/IEC version of ANSI X3.220:1992.
Editor/Point-of-Contact:	
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Telephone/Fax:	+41-22-749-0111 +41-22-733-3430 (fax)
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WWW URL:	**http://www.iso.ch/welcome.html**

ISO 9660

Standard:	Volume and File Structure of CD-ROM for Information Interchange
Designation:	ISO 9660-1988; High Sierra
Status:	IS, Formal
Publisher:	ISO
Date of Publication:	1988
Description:	This standard specifies the logical layout of information on a CD-ROM disk so that the information can be viewed as a file-structured magnetic storage device. The initial draft was developed (1985) by the High Sierra Group, which consisted of Apple, DEC, Hitachi, LazerData, Microsoft, 3M, Phillips, TMS Reference Tech, VideoTools, Xebec, and Yelick. It makes the CD-ROM look like a data file. Also, it defines hierarchical file and directory structure, its logical sectors, logical blocks, fixed-length records, variable length records, and a character-encoding scheme.
Editor/Point-of-Contact:	
Address:	International Organization for Standardization Case Postale 56 CH-1211 Geneva 20 Switzerland
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SQL

Standard:	Information Processing Systems - Database Language, Software Query Language (SQL), SQL-2, and SQL-3
Designation:	ISO 9075:1987; ISO/IEC 9075:1992; FIPS 127-2; SC21 N6931
Status:	IS; Formal; SQL-3 under development
Publisher:	ISO
Date of Publication:	First edition (SQL-1) 1987; Second edition (SQL-2) 1992; 1992
Description:	Structured Query Language. Data description and access language for relational databases. SQL-3 will consist of the following parts: WD 9075-1, Part 1: Framework (CD status expected 1995) WD 9075-2, Part 2: Foundation (CD status expected 1995) DIS 9075-3, Part 3: SQL Call Level Interface (CLI) (IS status expected late summer 1995) CD 9075-4, Part 4: Persistent SQL Modules (PSM) (DIS status expected late summer 1995) WD 9075-5, Part 5: Host Language Bindings (CD status expected 1995)
Editor/Point-of-Contact:	Len Gallagher
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WWW URL:	**http://speckle.ncsl.nist.gov/**

SQL - MM

Standard:	Information Technology - SQL Multimedia and Application Packages
Designation:	SC21/WG3 N1678, 1679, 1680
Status:	Working Draft
Publisher:	ISO/IEC SC21/WG3
Date of Publication:	March 1994
Description:	The new work item that will define extensions to the SQL database access language to support the storage and retrieval of multimedia datatypes. It will consist of four parts: Part 1: Framework Part 2: Full Text Part 3: Spatial Part 4: General Purpose Facilities
Editor/Point-of-Contact:	Len Gallagher
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APPENDIX A.11

DISTRIBUTED MULTIMEDIA ENVIRON-MENT

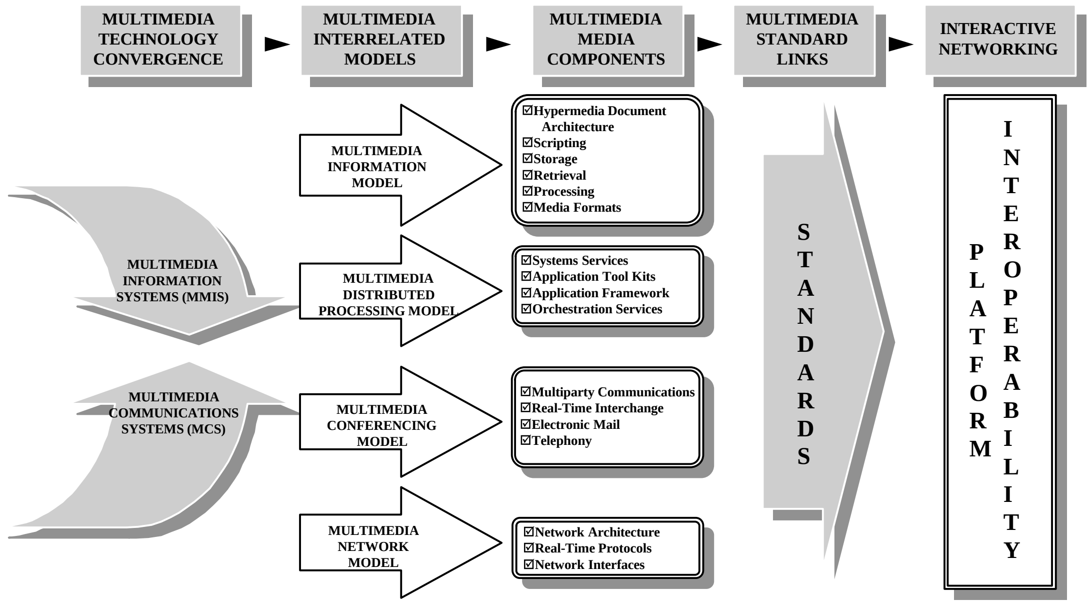
A.11 DISTRIBUTED MULTIMEDIA ENVIRONMENT

IMPACT OF STANDARDS ON DISTRIBUTED MULTIMEDIA ENVIRONMENTS

A decision to transmit multimedia over a network means that many standards must be considered. Adding a mix of sound, image, and video into a network requires more disk storage, more powerful processors, faster networks, and advanced software or special hardware. Figure V provides sample of file sizes needed for storing various media.

GOSIP, a multilayered network standard formerly required for Govern ment contracts, is no longer mandatory. Although GOSIP as a network standard has fallen out of favor, the application layer remnants of GOSIP are still used: X.400 (E-mail standards) and X.500 (electronic directory standards). They are now being used in conjunction with TCP/IP rather than the GOSIP Federal Information Processing Standard (FIPS).

The user community has found the X.400 E-mail standard superior to TCP/IP's Simple Mail Transfer Protocol (SMTP). Mike Parsons (Federal Computer Week, Technical Briefing, 25 July 1994) points out that, "X.400 allows you ultimately to sit at your keyboard, work in a favorite word processor, and send that file (text or graphics) across the country, shipping it from Point A to Point B. You can't do that with standard Internet mail." TCP/IP is generally used for the transport and network layers; but, the X.400 and X.500 standards of GOSIP are still used at the applica tions layer. Figure VI shows the name of the standards/formats in layers between the user and the network.



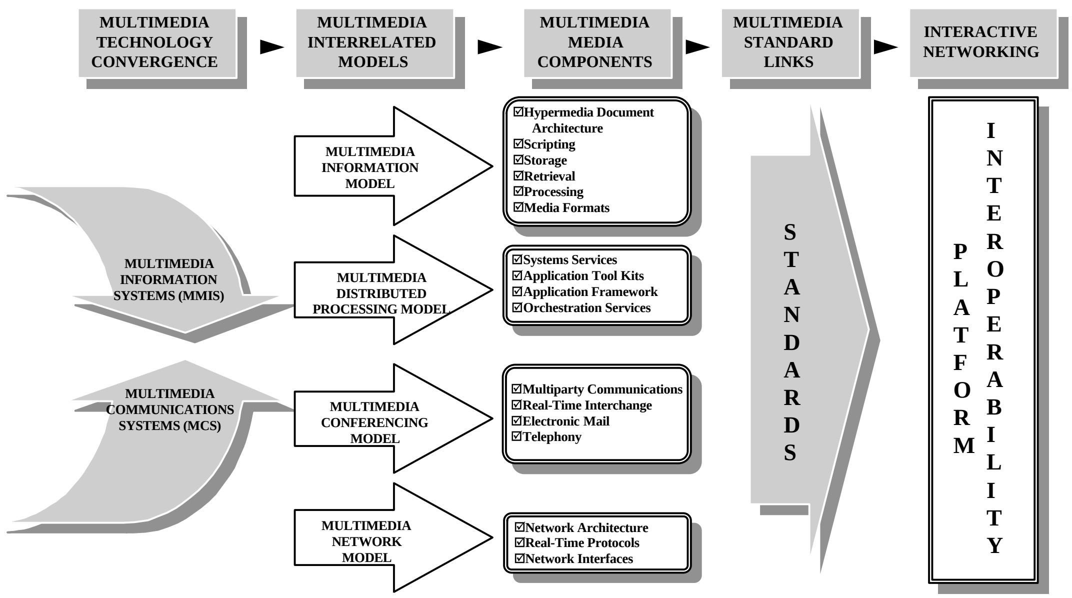
Broadcast Engineering, February 1993

Figure V. Sample File Sizes of Various Media

The Draft IMA Recommended Practice for a Multimedia System Services, (May 1995) addresses issues of creating, transmitting, and playing synchronized multimedia information within a distributed-computing environment and among different operating systems and processors. It will be Part 4 of Presentation Environment for Multimedia Objects (PREMO), the ISO/IEC JTC1 SC24/WG6 effort to address the creation and presentation of and interaction with all forms of information using single or multiple media.

IMA Recommended Practice for Data Exchange is based on Bento, part of the OpenDoc standard interchange format developed by Apple and Avid Technology's Open Media Framework Interchange (OMFI). The Recommended Practice defines a flexible file container format and frame work for data exchange, providing a solution for moving large amounts of multime dia data - including graphics, animation, audio, motion video and text - between different computer platforms.

In LAN terms, the Bento wrapper or OMF container is comparable to a data packet with header information that holds multimedia objects and various digital and analog data types, each with an associated data struc ture. When adding multimedia ele ments (such as motion video, still images, and sound) to a file, the task becomes more complicated. Bento/OMF containers also incorporate a set of rules for storing audio, video, or other objects so software in the receiving system understands the rules and can find the objects, determines what they are, and uses them correctly. The structure and syntax must be common, but the contents may vary. The "con tainer" is a transport language that describes actions and interactions without using platform-specific software codes. It comple ments the existing system-specific scripting language rather than replacing it.



<u>OEM Magazine</u>, February 1994

Figure VI. Various Layers of Standards/Formats Have Resulted in a Multimedia "Tower of Babel" Regarding Selection in a Distributed Network Environment

The most complicated multimedia transmission is motion video. With both hardware-assisted and software-only playback of digital video available, users have a range of compression algorithms to choose for their applications. Users tend to choose the algorithm that closely fits their application and satisfies the various factors of data rate, quality, and playback costs (such as the hardware, software, and platform).

Networks optimized for carrying packet data, such as an Ethernet, do a poor job of carrying packetized, full-motion video, which requires delivering packets in a particular order and with small, consistent delays. The issue of video quality is, and will always be, an important consideration when choosing a digital video compression system.

Digital multimedia transmission problems include continuous stream handling and multiple stream synchronization. In addition to their large data requirements, digital video and audio are time-based, continuous data streams that must be delivered at a certain rate and without interruption. This requires that continuous stream-handling capabilities exist between a client and the multimedia data server, both within a single node and across a network. A data server must monitor network load, system load, and user activity to control the continuous presentation of video and audio data streams.

A data server must provide video and audio synchronization capability. When data streams are out of sync, the server must apply techniques for bringing the data streams back into sync. For example, if audio lags behind video, the data server can repeat video frames until the audio catches up. As with continuous data stream delivery, synchronization needs to occur within and across a network. Data streams may originate at disparate data locations, increasing the difficulty of the continuous stream and synchronization task.

If separate encoding is done, there must be a process for combining the audio and video element into one stream for playback. Encoders that compress audio and video using a single computer system clock have an easier time during the audio/video interleaving (AVI) process. File size is an important consideration.

Networks that provide the additional bandwidth needed to support multimedia are now emerging. Many are extensions to Ethernet or Fiber Distributed Data Interface (FDDI) standards that run over existing cable

Table VIII. File Size of Various Media Before and After Compression

		Network Requirement		
Digital Media Type	**Information Content (Megabits)**	**Peak**	**Compression**	**Compressed**
Full-motion video	240	240	MPEG II	4.0
Color photograph (4x5 in.)	5.4	21.6	JPEG	1.44
B&W* photograph (4x5 in.)	1.8	7.2	JPEG	0.48
Audio (LP record quality)	0.68	0.68	ADPCM	0.17
Voice	0.064	0.064	ADPCM	0.016
Video-conferencing (QCIF)*	0.560	0.560	H.261	0.128
Text page	0.020	0.08	Lossless	0.04
Graphics page	0.100	0.4	Lossless	0.2
Animation (20 fps)	3.0	3.0	JPEG	0.2

*B&W, black and white; QCIF, quarter common intermediate format
Broadcast Engineering, July/August 1994

plants, but that may require users to swap out network interface boards. Table VIII shows the impact of compression on various media.

One solution is to purchase a new LAN infrastructure. Asynchronous Transfer Mode (ATM) is a fast, packet-switching technology that allows the creation of virtual channels that can support isochronous-like connections. Synchronous FDDI is another option. It is part of the ANSI X3T9.5 FDDI standard. Traffic is not subject to packet delays and the bandwidth can handle simultaneous voice conversations. Another option is Fibre Channel (FC) Standard network. FC is an ANSI X3T9.3 standard.

Other video considerations are whether the software/hardware include a flicker filter, color correction (NTSC-safe colors), key-channel control, or gamma adjustment. In the future, video servers will also handle analog-to-digital conversions and provide gateways to other video networks such as cable television, phone company services, video conferencing, and multipoint video conferences.

Presently, there is no single standard for high-quality, full-motion video transmission over a network. The user must consider each characteristic individually and then choose the best alternative.

An example of a community that needs high-end digital multimedia capabilities is the medical community. Medical community requirements include data access, image processing and retrieval, intelligent query to large databases, security and privacy, financial and accounting processing, real-time teleconferencing, real-time data acquisition, on-line consulting (information exchange), quality control, continuous training and education, distribution, maintenance and updates, and user feedback.

Another useful application of multimedia would be storing and retrieving data relevant to a specific weapons system. Imagine an integrated weap ons systems database (IWSDB) where all the Interactive Electronic Techni cal Manuals (IETMs) had digital video streams in a database for training, operations, maintenance, and trouble-shooting. This would be the type of "competitive advantage" that the CALS Program was created to deliver.

ATM

Standard:	ATM (Asynchronous Transfer Mode)
Designation:	
Status:	Formal
Publisher:	ITU-T and IEEE
Date of Publication:	early 1980s
Description:	ATM is a connection-oriented, fast, packet-switched network service based on the transmission of small, fixed-sized packets known as cells. This data-transmission technology promises to speed up network performance, link LANs and telephone systems, and provide enough bandwidth for multimedia traffic.

ATM Forum; various ITU-T Study Groups including:

SG 15, Question 16, Speech, Voice Band and Audio Transmission in ATM/B-ISDN System

SG 15, Question 18, ATM Equipment

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WWW URL:	**http://atmforum.com**

BENTO

Standard:	Bento
Designation:	1.0d5
Status:	Vendor
Publisher:	Apple Computer
Date of Publication:	September 1992
Description:	Bento is a specification for the format of "object containers" and an associated API. In this context, an "object" such as a word processor document or a movie clip typically composes some *metadata* (data about the object's format) and a *value* (the content of the object). A "container" is some form of data storage or transmission (e.g., a file or a part of a mail message). Bento containers are defined by a set of rules for storing multiple objects in such a container. Bento does not require individual objects to be "Bento-aware."

Bento can store deltas to an object, and can store objects in compressed or encrypted form, where compression/encryption algorithms may be specified externally. Bento can store external references to data (for instance to a large movie file, perhaps itself part of a Bento container, stored on a file server) and can also store a limited-resolution version for use when the file server version is unavailable.

Unlike other similar standards such as Abstract Syntax Notation.1 (ASN.1) and Open Document Architecture (ODA), Bento allows for the storage of multimedia objects in a medium-specific interleaved layout (say, on a CD-ROM) suitable for "just-in-time" real-time display.

The Bento specification also contains an API.

Bento is platform independent; is suitable for random-access reading (when a container is in RAM or on disk); has an "update-in-place" mechanism supported in the API, but not yet in format specification or implementation; and has a globally unique naming system for objects and their properties. Names can be allocated locally for casual use or registered for common use; objects are extensible (new information may be added to an object without disrupting applications that don't understand the new information); supports links between/among objects; provides recursive access to embedded Bento containers; can store a single object in several different formats (e.g., with different byte-ordering); and is not a general-purpose object database mechanism.

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WWW URL: http://www.apple.com/dev/du/intro_to_opendoc/iod4_underlying_technology.html#Bento

CORBA

Standard:	OMG Common ORB (Object Management Group, Common Object Request Broker) Architecture (CORBA)
Designation:	CORBA
Status:	Industry, Informal
Publisher:	OMG
Date of Publication:	September 1992
Description:	CORBA provides the mechanisms by which objects make requests and receive responses in distributed environments. CORBA is intended to provide interoperability among applications on different computers in heterogeneous, distributed environments and to inter-connect different object systems. As presently defined, CORBA includes no standard encoding, so different CORBA implementations are not yet interoperable. CORBA 1.1 and 1.2 specify the OMG's Object Management architecture whereby object systems make requests and receive responses in distributed environments. (CORBA 1.2 is a minor revision from 1.1) CORBA 2.0 adds a single mandatory interoperability protocol, an additional family of optional protocols, and a standard gateway architecture which ensure out-of-the-box interoperability among independently constructed CORBA 1.1/1.2 implementations.
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WWW URL:	**http://www.omg.org/**

COSS

Standard:	Common Object Services Specification (COSS)
Designation:	OMG COSS I (formerly JOSS, Joint Object Services Specification); also called CORBAservices
Status:	Industry, Informal
Publisher:	Object Management Group (OMG)
Date of Publication:	April 1995
Description:	OMG COSS is a joint specification by DEC, Group Bull, HP, HyperDesk, Itasca, Novell, OZ, Object Design Objectivity, Ontos, Servio, Sunsoft, Tivoli, and Versant to the OMG. COSS (also called CORBAservices) covers a set of eight services critical to realizing and maintaining objects within a distributed computing environment. COSS is a key component that is necessary to build distributed, interoperable, object-based systems.
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DCE

Standard:	Distributed Computing Environment (DCE)
Designation:	DCE 1.1
Status:	Industry, Informal
Publisher:	OSF
Date of Publication:	1991; 1994
Description:	The OSF's Distributed Computing Environment (DCE) is a comprehensive set of services that support the development, use, and maintenance of distributed applications. DCE allows diverse systems to work together cooperatively and masks the technical complexities of the network. Because DCE is independent of the operation system and network, it is compatible with many diverse environments currently in place by users.The DCE provides a set of integrated services that work across multiple systems and are independent of any particular system. DCE consists of a set of coordinated services including File Service, RPC Service, Security Service, Directory Service (XDS), Time Service, and Threads. All these services are based on an RPC mechanism and on the concept of administrative units called cells. DCE 1.1 offers major enhancements. Improved administrative functions are: 1) Single Administrative DCE Control Program (decep); 2) D+CE Deamon (dced); 3) Serviceability Improvements; 4) Cell Aliasing; and 5) Hierarchical Cells.

	Improved security includes 1) Security Delegation; 2) Auditing; 3) Extended Generic Security Service Application Program Interface; 4) Extended Registry Attributes; and 5) Extended Login Capabilities. Other improvements include Internationalization and Performance Enhancements.
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DE

Standard:	IMA Recommended Practice for Data Exchange (DE)
Designation:	
Status:	Industry Recommended Practice
Publisher:	Interactive Multimedia Association (IMA)
Date of Publication:	July 1995
Description:	This Recommended Practice is based on Bento, part of the OpenDoc standard interchange format developed by Apple and Avid Technology's Open Media Framework Interchange (OMFI). The Recommended Practice defines a flexible file container format and framework for data exchange, providing a solution for moving large amounts of multimedia data - including graphics, animation, audio, motion video and text - between different computer platforms. The Practice supports two levels of data exchange that address the need to exchange discrete multimedia data types as well as multimedia data compositions which include audio, video, and/or graphics, thereby allowing developers to select the method of exchange that suits their needs.
Editor/Point-of-Contact:	Scott Lewis
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EDI AND UN/EDIFACT

Standard:	EDI (Electronic Data Interchange) Parts 1-22
Designation:	ANSI X.12 -1986 (EDI); ISO 9735:1988 (UN/EDIFACT); FIPS 161
Status:	IS; Formal
Publisher:	ANSI; ISO; FIPS
Date of Publication:	1988; 1990; 1991
Description:	EDI is the electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data. EDI is designed to help the exchange of business data by electronic means among manufacturers, wholesalers, distributors, retailers, shippers, consignees, carriers, banks, insurers, and government agencies. UN/EDIFACT is the EDI For Administration, Commerce, and Transport, harmonized under the auspices of the United Nations.
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WWW URL:	**http://www.ansi.org/docs/home.html** **http://www.premenos.com/EDIStandards.html**

EDI OVER X.400

Standard:	EDI (EDI Messaging System over X.400 1988 with P.edi)
Designation:	ITU-T X.435, ITU-T F.435; also ISO/IEC 13208 and 13209
Status:	IS; Formal; ITU Recommendation
Publisher:	ITU-T
Date of Publication:	1991 (ITU-T); 1993 (ISO/IEC)
Description:	These two ITU-T recommendations (ISO standards) specify the System (X.435) and the Service (F.435) for sending EDI messages as part of an X.400 message handling service.
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FC

Standard:	Fibre Channel (FC)
Designation:	ANSI X3.230-1994 - FC - Physical and Signaling Interface (FC-PH) ANSI X3.254-1994 - FC - Mapping to HPPI-FP (FC-FP)
Status:	ANSI; IS; Formal
Publisher:	ANSI/ISO
Date of Publication:	1994
Description:	FC is a family of related standards that specifies the implementation and low-level characteristics as well as the services and protocols for providing high- speed connectivity over fiber-optic cable. In addition to the two approved ANSI standards above (which are being processed as ISO standards as well), ANSI Technical Committee X3T11 is developing other standards: FC - Arbitrated Loop (FC-AL) FC - Arbitrated Loop-2 (FC-AL-2) FC - Avionics Environment (FC-AE) FC - Fabric Generic Requirements (FC-FG) FC - Generic Services (FC-GS) FC - Generic Services-2 (FC-GS-2) FC - Implementation Guide (FC-IG) FC - Link Encapsulation (FC-LE) FC - Mapping to Asynchronous Transfer Mode (ATM) Protocol (FC-ATM) FC - Physical and Signaling Interface-2 (FC-PH-2) FC - Physical and Signaling Interface-3 (FC-PH-3) FC - Single-Byte Command Code Sets (SBCCS) (FC-SB) FC - Switch Topology (FC-SW) FC Protocol for SCSI (FCP)

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FDDI

Standard:	Fiber Distributed Data Interface (FDDI)
Designation:	ISO/IEC 9314-1:1989, FDDI Part 1: Physical Layer Protocol (ANSI X3.148-1988) ISO/IEC 9314-2:1989, FDDI Part 2: Media Access Control (MAC) (X3.139:1986) ISO/IEC 9314-3:1990, FDDI Part 3: Physical Layer Medium Dependent (PMD) (ANSI X3.139-1986) ISO/IEC 9314-4, FDDI Part 4: Single-Mode Fibre/Physical Layer Medium Dependent (ANSI X3.184-1993) ISO/IEC 9314-5:1995, FDDI Part 5: Hybrid Ring Control (FDDI-II) (ANSI X3.186-1992) ISO/IEC CD 9314-6, FDDI Part 6: Station Management (SMT) Standard (ANSI X3.229-1994)
Status:	ANSI; IS: Formal
Publisher:	ANSI; ISO/IEC
Date of Publication:	1986; 1988; 1993
Description:	FDDI is a standard network protocol, similar to token ring, that provides a raw data rate of 100 Mbps and uses fiber-optic-based transmission.
Editor/Point-of-Contact:	Gene Milligan
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WWW URL:	

FRAME RELAY

Standard:	Frame Relay
Designation:	Various, see ITU-T and ANSI listings
Status:	Vendor; ITU-T; ANSI
Publisher:	Frame Relay Forum; ITU-T; ANSI
Date of Publication:	Various, beginning in 1990
Description:	Frame relay is a North American public service that predates cell-based network relay technologies, such as ATM, variable- length data packets, and combines statistical multiplexing, port-sharing, and Time Division Multiplex (TDM) techniques.
Editor/Point-of-Contact:	Frame Relay Forum
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E-mail address:	**frf@interop.com**
WWW URL:	**http://frame-relay.indiana.edu/**

HPPI

Standard:	HPPI (High Performance Interface) Parts 1-6
Designation:	X3.183:1991; ISO/IEC 11518-1:1995; DIS 11518-2; DIS 11518-3; DIS 11518-6
Status:	IS; ANSI; Formal
Publisher:	ISO/IEC; ANSI
Date of Publication:	1991; 1995 (Part 1)
Description:	HPPI-PH is another low-level networking standard (similar to Fiber Channel) but designed to operate at much higher bandwidths.
Editor/Point-of-Contact:	Don Tolmie
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ITU-T X.400

Standard: Message-Oriented Text Interchange System MOTIS)/Message Handling System (MHS)

Designation: ITU-T X.400; ISO 10021 (Parts 1-9)

Status: ITU-T Recommendation; IS; Formal

Publisher: ITU-T; ISO/IEC

Date of Publication: ITU-T (1993-Rev. 1); ISO/IEC (1990)

Description: The aim of the X.400 standards is to provide an international service for the exchange of electronic messages without restricting the types of encoded information conveyed.

X.400 clearly distinguishes between message envelope, which controls the message transfer process, and message content, which is passed transparently from originator to recipient. Hence, any type of encoded information may be exchanged without loss or corruption. The most common content-type in use is the interpersonal-messaging content-type. This format divides content into two parts: heading and body. Heading fields (with labels such as "from," "to," and "subject") convey standard items of information. The message body consists of one or more body parts, each of which may contain a different type of encoded information.

X.400 has two further features that make it suitable for conveying multimedia information. First, the use of ASN.1, guarantees data transparency and offers a choice of encodings, including a space-optimized "packed encoding." Second, the use of the Reliable Transfer Application Service Element provides a tolerant data transfer mechanism with recovery from connection failure. This is especially important for multimedia messages, which are typically large.

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MHEG

Standard:	MHEG (Coded Representation of Multimedia and Hypermedia Information Objects)
Designation:	Part 1: MHEG Objects Representation - Base Notation (ASN.1) Part 2: Alternate Notation (SMSL) Part 3: MHEG Extensions for Scripting Language Support (MHEG-S) Part 4: Registration Procedure for MHEG Format Identifier
Status:	DIS 13522-1; WD 13522-2; WD 13522-3; DIS 13522-4
Publisher:	ISO/IEC
Date of Publication:	Various, Part 1 was expected to reach IS status in November 1994.
Description:	MHEG stands for the Multimedia and Hypermedia Information Coding Experts Group. This group is developing a standard "Coded Representation of Multimedia and Hypermedia Information," commonly called MHEG. MHEG is suited to interactive hypermedia applications such as on-line textbooks and encyclopedia. It is also suited for many of the interactive multimedia applications currently available (in platform-specific form) on CD-ROM. MHEG could be used as the data structuring standard for a future home-entertainment interactive multimedia appliance.

To address such markets, MHEG represents objects in a nonrevisable form, and is therefore unsuitable as an input format for hypermedia authoring applications; its place is perhaps more as an output format for such tools. MHEG is not a multimedia document-processing format, instead it provides rules for structuring multimedia objects that permits the objects to be represented in a convenient form (e.g., video objects could be MPEG-encoded). MHEG uses ASN.1 as a base syntax to represent object structure, but allows for the use of other syntax notations.

An SGML syntax is also specified. MHEG objects (which may be textual information, graphics, video, audio, etc) may be of four types: input object (i.e., a user control such as a button or menu); output object (e.g., graphics, audio visual display, text); interactive object (a "composite" object containing both input and output objects); and hyperobject (a "composite" object containing both input and output objects, with links between them).

MHEG supports various synchronization modes for presenting output objects in these relationships.

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MIME

Standard:	MIME (Multipurpose Internet Mail Extensions), Part 1: Mechanisms for Specifying and Describing the Format of Internet Message Bodies , Part 2: Message Header Extensions for Non-ASCII Text
Designation:	Part 1 - RFC 1521 (obsoletes RFC 1341); Part 2 - RFC 1522 (obsoletes RFC 1342)
Status:	Internet Request for Comment
Publisher:	Internet - Network Working Group
Date of Publication:	June 1992
Description:	This RFC provides facilities to include multiple objects in a single message; represent body text in character sets other than US-ASCII represented formatted, multi-font text messages; represent nontextual material such as images and audio fragments; and help later extensions define new types of Internet mail for use by cooperating mail agents. MIME supports not only several pre-defined types of nontextual message contents, such as 8-bit 8000Hz-sampled µ-Law audio, GIF image files, and PostScript programs, but also permits defining types of message parts. RFC 822 defines a message representation protocol that specifies detail about message headers, but that leaves the message content, or message body, as flat ASCII text.

RFC1521 redefines the format of message bodies to allow multipart textual and nontextual message bodies to be represented and exchanged without losing information.
MIME provides facilities to include multiple objects in a single message, represent body text in character sets other than US-ASCII, represent formatted multifont text messages, represent nontextual material such as images and audio fragments, and help later extensions define new types of Internet mail for use by cooperating mail agents. Part 2, RFC1522, extends Internet mail header fields to permit other then US-ASCII text data.

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WWW URL: **http://www.oac.uci.edu/indiv/ehood/MIME.html**

MSS

Standard:	MSS (Multimedia System Services)
Designation:	IMA Recommended Practice for Multimedia Systems Services
Status:	Consortium Draft
Publisher:	IMA
Date of Publication:	May 1995
Description:	MSS provides an infrastructure for building multimedia computing platforms that support interactive multimedia applications dealing with synchronized, time-based media in a heterogeneous, distributed environment. MSS marshals lower-level system resources to the task of supporting multimedia processing, providing a set of common services that multi media application developers can use on an industry-wide basis. It will be Part 4 of PREMO.
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ODP REFERENCE MODEL

Standard:	Information Technology - Open Distributed Processing - Reference Model - Open Distributed Processing - Parts: 1-4
Designation:	ISO/IEC 10746; Part of future ITU-T X.900 series
Status:	Parts 2 and 3 are at DIS; IS expected November 1995
Publisher:	ISO/IEC
Date of Publication:	April 1994
Description:	This is a multipart standard providing a coordinating framework for the standardization of ODP. It consists of an overview and guide to use (Part 1), descriptive model (Part 2), prescriptive model (Part 3), and a set of architectural semantics and formalisms (Part 4). These models define a set of "languages," each providing a different view of ODP (enterprise, information, computation, and engineering) and a set of functions (management, security, etc.).
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OMHEGA

Standard:	Open MHEG Architecture (OMHEGA)
Designation:	OMHEGA
Status:	Emerging
Publisher:	European Programme for Research in Information Technology (ESPRIT)
Date of Publication:	Draft expected 1995
Description:	OMHEGA aims at specifying and validating a generic system architecture based on ISO/IEC DIS 13522-1, MHEG. The architecture will serve as a basis for future multimedia and hypermedia applications developments in open, distributed environments.
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http://www.newcastle.research.ec.org/esp-syn/index.html

OSI DIRECTORY

Standard:	Information Processing Systems - OSI (Open Systems Interconnection) - The Directory - Parts 1-9
Designation:	ISO/IEC 9594-1-9:1990; also part of ITU-T X.500 series
Status:	IS; Formal; undergoing revision
Publisher:	ISO
Date of Publication:	1990; undergoing revision
Description:	The OSI Directory provides a name-to-value translation service for systems that adhere to the OSI protocol standards. In particular, the service can be used to provide name- to-address translation (that gives location independence to objects in distributed systems) and to retrieve lists of objects based on their properties.
Editor/Point-of-Contact:	Sharon Boeyen
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OSI REFERENCE MODEL

Standard: Information Processing Systems OSI (Open Systems Interconnection Reference Model) Part 1: Basic Reference Model; Part 2: Security Architecture; Part 3: Naming and Addressing, Part 4: Management Framework

Designation: ISO/IEC 7498-1:1994; ISO/IEC 7498-2:1989; ISO/IEC 7498-3: 1989; ISO/IEC 7498-4:1989

Status: IS; Formal

Publisher: ISO/IEC

Date of Publication: 1989; 1994 (Part 1)

Description: The OSI standard provides a common basis for coordinating standards development for the purpose of systems interconnection. It is most commonly thought of in terms of the seven layers of abstraction (from Physical to Application) that it defines; but it in fact includes a wealth of standardized concepts and language for describing communications systems.

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PREMO

Standard:	Presentation Environment for Multimedia Objects (PREMO)
Designation:	PREMO
Status:	ISO/IEC standard under development
Publisher:	ISO/IEC JTC1 SC24 WG6
Date of Publication:	
Description:	PREMO addresses the creation of, presentation of, and interaction with all forms of information using single or multiple media. In particular, it addresses the issues of configuration, extension, and interoperation of and between PREMO implementations. PREMO will support still computer graphics, moving computer graphics (animation), synthetic graphics of all types, audio, text, still images, moving images (including video), images coming from imaging operations, and other media types of combinations of media types that can be presented. PREMO complements the work of other emerging ISO standards on Multimedia, such as MHEG, HyperODA, and HyTime. Typically, these standards do not aim at the presentation of media objects, but deal primarily with aspects of the interchange of multimedia information.
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QoS

Standard:	Information Technology - Quality of Service Framework
Designation:	SC21/WG1 N 1298
Status:	Third WD
Publisher:	ISO/IEC
Date of Publication:	January 1994
Description:	This standard provides a framework for defining the QoS that is requested by one OSI layer from the next lower layer. The standard includes definitions and parametric descriptions for things such as bandwidth, jitter, and residual errors.
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RDA

Standard: Information Technology - Remote Database Access - Part 1: Generic Model, Service and Protocol, Part 2: SQL Specialization, Part 3: SQL Specialization Protocol Implementation Conformance Statement (PICS) Proforma

Designation: ISO/IEC 9579-1:1993; ISO/IEC 9579-2:1993, ISO/IEC DIS 9579-3

Status: IS; Formal

Publisher: ISO/IEC

Date of Publication: 1993; Part 3 DIS

Description: In many environments, there are heterogeneous database systems that need to be interconnected. The RDA standard provides the communication mechanisms to integrate such systems. It provides independence such that a RDA user can use the same front end to access different database systems, and a single database may be shared by different workstations. RDA specifies a two-way transfer syntax as well as the semantics for database operations.

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RIFF

Standard:	Resource Interchange File Format
Designation:	File structure for multimedia resources.
Status:	Vendor
Publisher:	Microsoft and IBM
Date of Publication:	
Description:	RIFF is a family of file structures rather than a single format. RIFF file architecture is suitable for the following multimedia tasks: playing back multimedia data; recording multimedia data; and exchanging multimedia data between applications and across platforms. A RIFF file consists of a number of "chunks" that identify, delimit, and contain each resource stored in the file. Two special chunks allow nesting of multiple chunks. These are the "RIFF" chunk, which combines multiple chunks into a "form," and "list," which is a list or sequence of chunks. Certain chunk types (including all form and list types) should be globally unique. To guarantee this uniqueness there is a registration scheme run by Microsoft, where new chunk types may be registered and a list of current registrations may be obtained. RIFF files are supported in Windows 3.1 under MS DOS and by MMPM/2 under OS/2.
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WWW URL: **http://www.microsoft.com**

RTP

Standard:	Real-Time Transport Protocol (RTP)
Designation:	Transport protocol for audio and video conferences and other multiparticipant, real-time applications
Status:	Draft
Publisher:	IETF Audio/Video Transport Working Group
Date of Publication:	
Description:	Services typically required by multimedia conferences are playout synchronization, demultiplexing, media identification, and active-party identification. RTP is not restricted to multimedia conferences; other real-time services such as data acquisition and control may use its services. RTP is supported by a real-time control protocol (RTCP). Conferences encompassing several media are managed by a reliable conference protocol. RTP services are framing, demultiplexing by conference/association, demultiplexing by media source, demultiplexing by media encoding, synchronization between source(s) and destination(s), error detection, encryption, and quality-of-service monitoring. RTP consists primarily of a protocol header for real-time data packets.
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WWW URL:

SMDS MAN

Standard:	SMDS (Switched Multimegabit Data Service) MAN (Metropolitan Area Network Service)
Designation:	IEEE 802.6; ISO/IEC 8802-6:1994
Status:	IS; IEEE; Formal
Publisher:	IEEE 802.6 Isochronous Working Group
Date of Publication:	1992; 1994
Description:	This standard defines isochronous enhancements to the Distributed Queue Dual Bus (DQDB) standard (802.6) for creating subnetworks of a Metropolitan Area Network (MAN) for applications requiring periodic, recurring bandwidth. The intended applications include: - Interconnection of PBX's with DS-1 or E1 trunks - Video applications for constant-bit-rate/variable-image quality applications from 348 KBps to 44.2097 MBps - Voice - Multimedia, including H.221, H.261, and MPEG 1
Editor/Point-of-Contact:	SMDS Special Interest Group
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WWW URL:	**http://stdsbbs.ieee.org:70/0/pub/ieeestds.htm**

SONET/SDH

Standard: SONET/SDH (Synchronous Optical Network/Synchronous Digital Hierarchy)

Designation: SONET is the ANSI designation and SDH the ITU-T designation.

Status: ITU-T Recommendations; ANSI standards

Publisher: ITU-T; ANSI

Date of Publication: Various, see ITU-T and ANSI listings.

Description: SONET is an optical transmission interface standardized by ANSI. A comparable version, referred to as SDH, has been published by ITU-T in Recommendations G.707, G.708, and G.709. Each is intended to provide a specification for taking advantage of the high-speed digital transmission capability of optical fibre. SONET defines a hierarchy of standardized digital data rates. ANSI designations are specified in terms of the synchronous transport signal level and corresponding optical carrier level, whereas ITU-T designations are in terms of synchronous transfer model level.

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APPENDIX A.12

FUTURES

A.12 FUTURES

Fax is currently an analog mix of paper and ink and is a combination of black and white characters that cannot stand alone. The data do not carry information about the number of pixels per line or the number of lines in the image. This information is included in an enveloping protocol for a fax transmission. This information must be included in a header if the file is sent via a computer network.

In the future, today's fax memo, a simple analog mix of paper and ink, will evolve into tomorrow's multimedia document, a digital page complete with image, sound, and video clips. Words, files, graphics, and audio or video clips become objects. Flexible, two-way links allow users to attach one object to another in various ways. Tools have grown out of various environments: desktop-publishing, hypermedia document editors, storyboard/script models, network software. A first step toward this is ITU-T Recommendation T.434, Binary File Transfer (see Appendix A.9), a new way to transfer actual files between fax modems as opposed to just the image of a document.

SGML: Work is underway to incorporate text within or with a graphic into the SGML database. The embedded text in a graphic would be accessible to the mark-up language. The title, or figure-textual information, would also be tagged.

The foundation for Microsoft's information highway strategy is Chicago, its next generation Windows 3.1 operating system. Microsoft's Tiger system for delivery of on-line multimedia, will go into small-scale use in late 1995 with commercial operation in 1996. It will work on a variety of hardware configurations. Unannounced public companies plan to use the system to deliver entertainment on demand, shopping, and bulletin boards. The company is expected to roll out its own modem-based network in 1995.

NASDAQ/MSFT: Recent alliances with TCI, Mobile Telecom, GE, and NITT are fundamental to Microsoft's broad systems software direction in providing easier-to-use, navigational software for non-PC information highway devices. Four percent of current revenues, or $145 million, are multimedia-based; this is expected to double by 1995. Tiger will be tested in Seattle in a joint venture with TCI. Intel and Compaq will announce Tiger-based products with potential for private networks.

An entirely different theory of compression developed by Iterated Systems Inc., is called fractal transform. This codec exploits Mandelbrot's discov ery of simple equations that generate natural-looking images in infinite detail. These images are broken into domains that can be described as squeezed-down, distorted versions of larger parts of "ranges" of the same image. It is considered a superior scheme for compressing still images, especially images from nature. Since it is based on equations, it can be expanded larger than the original, leading to claims of greater compres sion. Fractal artifacts include softness, as well as substitution of details by other details typically undetectable in a natural image.

Recently, Total Multimedia Inc. began offering fractal video-compression services that cost about $300 per finished minute (about the same as TrueMotion or Production Level Video [PLV]) or $26,000 per workstation. Total Multimedia representatives claim its Pro-Frac compression can deliver very low rates of 40 to 100 KB per second, and they boast com plete resolution independence, enabling high-quality zooms to higher resolutions. (Total Multimedia also sells an asymmet ric, PC-based software-only compression package called SoftVideo from $995 to $9,995.)

Another unique compression scheme is based on a mathematical tech nique called Wavelets, developed by Aware, Inc. A wavelet codec trans forms an image into a set of different spatial representations, some contain high frequencies, and one contains all the low-frequency informa tion. Wavelet artifacts are marked by softness, subtle random noise, and halos along edges (similar to JPEG ringing), except wavelets move when the edge moves. Wavelets can also compress audio, which can be decom pressed by a software-only playback codec. Wavelet compres sion is used in the ImMIX VideoCube editing system. Media Vision is using wavelet compression in its novel Captain Crunch video codec, which is in beta testing and will require low-cost hardware for playback.

With the power of today's codecs and the right hardware assistance on playback, 1994 will be remembered as the year full-motion video filled the computer screen.

VRML

Standard:	Virtual Reality Modeling Language (VRML)
Designation:	VRML v.1.0
Status:	Draft, Informal
Publisher:	
Date of Publication:	Third draft, May 26, 1995
Description:	VRML is a language for describing multi-participant interactive simulations -- virtual worlds networked via the global Internet and hyperlinked with the WWW. All aspects of virtual world display, interaction and internetworking can be specified using VRML. It is the intention of its designers that VRML become the standard language for interactive simulation within the WWW. VRML is based on the Open Inventory ASCII File Format from Silicon Graphics, Inc.
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APPENDIX B

ACRONYMS

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LIST OF ACRONYMS

ACR-NEMA	American College Of Radiologists/National Electrical Manufacturers Association.
ADPCM	Adaptive Differential Pulse Coded Modulation
ANSI	American National Standards Institute
API	Application Program Interface
ARIDPCM	Adaptive Recursive Interpolated Differential Pulse Code Modulation
ASCII	American Standard Code For Information Interchange
ATA	Airline Transport Association
ATM	Asynchronous Transfer Mode
ATSC	Advanced Television Systems Committee
AVI	Audio Visual Interleaving
AVS	Audio Visual Synchronization
CAD/CAM	Computer-Aided Design - Computer-Aided Manufacturing
CALS	Continuous Acquisition and Life-Cycle Support
CCIR	International Radio Consultative Committee (see ITU-R)
CCITT	Consultative Committee for International Telegraph and Telephone (see ITU-T)
CD	Compact Disk
CD	Committee Draft (ISO designation)
CD-DA	Compact Disk - Digital Audio
CD-I	Compact Disk Interactive
CD-OS	Compact Disk - Operating System
CD-R	Compact Disk - Recordable
CD-ROM	Compact Disk Read Only Memory
CD-ROM-XA	Compact Disk Read Only Memory-Extended Architecture
CD-WO	Compact Disk - Write Once
CFS	Center For Standards
CGI	Computer Graphics Interface
CGM	Computer Graphics Metafile
CIO	Central Imagery Office
CITIS	Contractor Integrated Technical Information Service
CODEC	COmpression and DECompression
CONOPS	CONcept of OPerationS

LIST OF ACRONYMS (Cont'd)

CORBA	Common Object Request Broker
COSS	Common Object Services Specification (formerly JOSS)
CPU	Central Processing Unit
CR-R	CR-Recordable
CT	Computer Tomography
DAT	Digital Audio Tape
DCC	Digital Compact Cassette
DCE	Distributed Computer Environment
DCT	Discrete Cosine Transform
DICOM	Digital Imaging Communications
DIS	Draft International Standard (ISO designation)
DISA	Defense Information Systems Agency
DLL	Dynamic Link Libraries
DoD	Department of Defense
DSP	Digital Signal Processor
DSSSL	Documentation Style Semantics and Specifica tions Language
DTD	Document Type Definition
DTR	Draft Technical Report (ISO designation)
DVI	Digital Video Interactive
DXF	Document Interchange Format
EBU	European Broadcasting Union
EDI	Electronic Data Interchange
E-MAIL	Electronic-Mail
EPS	Encapsulated PostScript
ESDI	Enhanced Small Device Interface
ESPRIT	European Programme for Research in Information Technolog
EUCS	Edinburgh University Computing Service
FC	Fibre Channel
FCC	Federal Communications Commission
FCS	Fiber Channel Standard
FDDI	Fiber Distributed Data Interface
FIMS	Forms Interface Management System
FIPS	Federal Information Processing Standard

LIST OF ACRONYMS (Cont'd)

FPS	Frames per Second
GCC	Generic Conference Control
GEL	Gain Technology Extensions Language
GIF	Graphics Interchange Format
GILS	Government Information Locator Service
GKS	Graphical Kernel System
GUI	Graphical User Interface
HDTV	High Definition Television
HP	Hewlett Packard
HTML	HyperText Markup Language
HYTIME	Hypermedia/Time Based Structuring Language
IAEG	Interagency working group for coordinated, Open-EDI standards development
IBM	International Business Machines
IDA	Institute for Defense Analysis
IDL	Interface Description Language
IEC	International Electrotechnical Commission
IEEE	Institute Of Electrical & Electronics Engineers
IETM	Interactive Electronic Technical Manual
IGES	International Graphic Exchange Specification
IIF	Image Interchange Facility
IMA	Interactive Multimedia Association
IPI	Image Processing and Interchange
IS	International Standard (ISO designation)
ISO	International Organization for Standardization
IT	Information Technology
ITS	Information Technology Standard
ITU	International Telecommunications Union
ITU-R	International Telecommunications Union- Radiocom
ITU-T	International Telecommunications Union - Telecomm
IV	Interactive Video
IWSDB	Integrated Weapons Systems Database
JBIG	Joint Bit Imaging Group
JIEO	Joint Interoperability and Engineering Organiza tion

LIST OF ACRONYMS (Cont'd)

JOSS	Joint Object Services Submission
JPEG	Joint Photographic Experts Group
JTC	Joint Technical Committee
KB	Kilobyte
KBPS	Kilobyte per Second
LAN	Local Area Network
MB	Megabyte
MCS	Multipoint Communication Service
MCU	Multipoint Control Units
MHEG	Multimedia and Hypermedia Experts Group
MHZ	MegaHertz
MIDI	Musical Instrument Digital Interface
MIL	Military
MIME	Multipurpose Internet Mail Extensions
MMC	Multimedia Marketing Council
MPC	Multimedia Personal Computer
MPEG	Moving Pictures Expert's Group
MS	Microsoft
MSS	Multimedia System Services
NASA	National Aeronautical Space Agency
NIST	National Institute for Standards and Technology
NITFS	National Imagery Transmission Format Standard
NTSC	National Television Standards Committee
ODA/ODIF	Office Document Architectures/Office Documentation Interchange Format
ODP	Open Distributed Processing
OLE	Object Linking and Embedding
OMF	Open Media Framework
OMFI	Open Media Framework Interchange
OMG	Object Management Group
OMHEGA	Open MHEG Architecture
OS	Operating System
OSF	Open Software Foundation

LIST OF ACRONYMS (Cont'd)

OSI	Open System Interconnection
PAL	Phase Alternating Line
PC	Personal Computer
PCM	Pulse Code Modulation
PCS	Personal Conferencing Specification
PDF	Portable Document Format
PHIGS	Programmer's Hierarchical Interactive Graphics System
PIP	Petroleum Industry Profile
PLV	Production Level Video
PM	Project Management
POSIX	Portable Operating System Interface for Computer Environments
PREMO	Presentation Environment for Multimedia Objects
QOS	Quality of Service
RARE	R'eseaux Associe's pour la Recherche Europe'enne-Singel
RAM	Random Access Memory
RDA	Remote Database Access
RDA SQL	Remote Database Access - Structured Query Language
RFD	Request For Deviation
RFT	Request For Technology
RO	Remote Operations
RPC	Remote Procedure Call
RTCP	Real-Time Control Protocol
RTF	Rich Text Format
SECAM	Sequential Couleur avec Memoire
SCSI	Small Computer System Interface
SGML	Standard Generalized Markup Language
SIF	Secure Input Format
SLRP	Scripting Language Recommended Practice
SME	Subject Matter Expert
SMPT	Society of Motion Picture and Television

LIST OF ACRONYMS (Cont'd)

SMPTE	Society of Motion Picture and Television Engineers
SMSL	Standard Multimedia Scripting Language
SONET/SDH	Synchronous Optical Network/Synchronous Digital Hierarchy
SPDL	Standard Page Description Language
SQL	Structured Query Language
TIFF	Tagged Image File Format
TM	Thermatic Mapper
TR	Technical Report (ISO designation)
UI	User Interface
UIC	University of Illinois, Chicago
URL	Universal Resource Locator
VQ	Vector Quantization
VTC	Video Teleconferencing
VTR	Video Tape Recorder
WAIS	Wide Area Information Server
WAN	Wide Area Network
WMF	Windows Metafile Format
WGDIA	Working Group on Digital Image Architecture
WWW	World-Wide Web

APPENDIX C

GLOSSARY

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GLOSSARY

asymmetric compression	Compression scheme that takes more than the running time of the video to compress, resulting in a higher-quality image than real-time compression.
audio clip	A portion of an audio file.
bi-level image	One bit per pixel-coded images.
binary code	EXE or executable version that has been compiled and linked.
client-server	Relationship between two or more processes that must cooperate for the performance of some task (applications).
compiled	Unlinked object version.
compression ratio	A comparison of input data to output data after compression, for example, 60:1.
consortia	An alliance, sometimes international, as of business organizations.
container files	When additional structure does not impose a rigid hierarchy among the data "chunks" contained therein, these "higher-level" files are called container files.
data interchange	Transferring of information between processes (applications or services)
de facto standard	Consensus by use when no formal standard exists.

GLOSSARY (Continued)

digital video	Video imagery that has been converted to a numerical or digital form.
distributed network systems	Applications communicating among themselves by exchanging messages.
direct mapping	Features file systems as directories, subdirectories, and files that may have direct analogs on the transmission media.
embedded	Code already contained within structured interchange files or data streams.
exchange set descriptors	Code that imposes relationships among data "chunks."
executable code	A file or program that contains instructions that can be performed (executed) by the CPU.
file formats	Description of a named, stored program or set of data.
formal standards	Standards that have been approved by the International Organization for Standardization (ISO) or other recognized standards body.
interchange	The storage and transmission of data.
interfaces	A description of a set of operations (or services) that a client may request of an object.

GLOSSARY (Continued)

interactive system — A system in which the user and the operating system communicate directly, with the operating system immediately acting on a command or request.

interleave (in video) — Audio information is transmitted along with the video signal in the blanking intervals (nonactive picture time) while the scanning beam is moving to its next start point.

interoperability — Refers to the ability of heterogeneous applications and platforms to successfully communicate.

lossless compression — Compression technique that preserves all the original information in an image or other data.

lossy compression — Compression technique that achieves optimal data reduction by discarding redundant and unnecessary information in an image.

multimedia authoring — Process of creating a multimedia application or "title."

multimedia technology — In the IMA RFT: MMSS - An application requiring more than two trips to the car to operate.

monomedia format — Data format that represents only one type of information. Information exchange at the simplest semantic level.

object code — The result when a program written in a high-level language is

GLOSSARY (Continued)

compiled (translated into binary machine code).

open-edi — Electronic data interchange among autonomous parties using public standards and aiming towards interoperability over time, business sectors, information technology system, and data types.

open systems — Network model for interconnection of heterogeneous computers and networks.

operating system — In a personal computer, the core program that provides applications with access to all of the hardware resources of the system.

paradigms — Patterns, examples, or models.

pixel — Tiny elements that make up a CRT picture on a screen.

portability — The ability to physically transport data and/or applications to a separate, heterogeneous platform and be able to render that data or execute that application without change.

presentation information — Tagged data stream of characters such as fonts, appearance, and underline.

proprietary standard — Standard developed and owned by a vendor or group of vendors.

raster graphics — Still-image formats.

GLOSSARY (Continued)

scripting languages	Interchange notation between authoring systems and players. Addresses the specification of, and operation on, all objects inherent to interactive multimedia applications, including (but not limited to) video, audio, still images, static and animated graphics, text user inputs, timed events, and device synchronization events.
source version	Uncompiled and unlinked version.
structural information (text)	Tagged data stream of characters as in paragraphs.
sub-band coding	Allows more lists to be allocated to the information most noticed.
symmetric compression	Compression scheme that takes as much time to compress an image sequence as it does to play back the image sequence.
synchronization	Deterministic relationship of separate multimedia data streams.
syntax	The grammatical form of a command.
user interface	The means by which a user communicates with a computer. It includes devices, objects on the screen, and sounds made by the computer in response to the user.
video clip	A portion of a video file.

APPENDIX D

REFERENCES

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